THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY

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VOL. XVIII.—FIFTH SERIES.

LONDON:
PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS.
SOLD BY LONGMANS, GREEN, AND CO.; SIMPKIN, MARSHALL, AND CO.; KENT AND CO.; WHITTAKER AND CO.: BAILLIÈRE, PARIS: MACLACHLAN AND STEWART, EDINBURGH: HODGES, FOSTER, AND CO., DUBLIN: AND ASHER, BERLIN.
1886.

"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exculta; malè doctis et barbaris semper inimica fuit."—Linnæus.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—Bruckner, *Théorie du Système Animal*, Leyden, 1767.

. . . . The sylvan powers
Obey our summons; from their deepest dells
The Dryads come, and throw their garlands wild
And odorous branches at our feet; the Nymphs
That press with nimble step the mountain-thyme
And purple heath-flower come not empty-handed,
But scatter round ten thousand forms minute
Of velvet moss or lichen, torn from rock
Or rifted oak or cavern deep: the Naiads too
Quit their loved native stream, from whose smooth face
They crop the lily, and each sedge and rush
That drinks the rippling tide: the frozen poles,
Where peril waits the bold adventurer's tread,
The burning sands of Borneo and Cayenne,
All, all to us unlock their secret stores
And pay their cheerful tribute.

J. Taylor, *Norwich*, 1818.

ALERE FLAMMAM.

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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

"................. per litora spargite muscum,
Naiades, et circùm vitreos considite fontes:
Pollice virgineo teneros hìc carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
N. Parthenii Giannettasii Ecl. 1.

No. 103. JULY 1886.

I.—*On* Aphis rumicis, *Linn., as a Pest on the Mangel-Wurzel Crops in Shropshire in the Autumn of* 1885, *and on a Fungus destructive of the same* Aphis. By Rev. WILLIAM HOUGHTON, M.A., F.L.S., and WILLIAM PHILLIPS, F.L.S.

[Plate III.]

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—I have to record the occurrence of a species of *Aphis*, which I take to be the *A. rumicis* of Linné, the *A. fabæ* of Curtis, infesting the leaves of the mangel plants in this neighbourhood, last September and October, to a considerable and very threatening degree. I never noticed any species of *Aphis* to any extent on mangel crops before last autumn. As a rule, this plant has, in our own country at least, comparatively few insect enemies. No record of mangels suffering much from any insect attack appears till the year 1844, when, in the north of Ireland, entire crops were destroyed by the larvæ of one of the carrion-beetles, *Silpha opaca*, which infested the young plants in spring, feeding on the leaves and leaving only the fibres; the roots were not attacked. In 1846 and 1847 they again injured the crops, and, indeed, to this day it appears that they continue to be an

Irish pest. A few other mangel enemies are known to have caused much damage in France, but not in this country, with the notable exception of the two-winged fly (*Anthomyia betæ*), which first, I think, in the autumn of 1862 attacked the crops in Shropshire and the Midland counties generally, causing very serious injury*. Since that date this *Anthomyia* has, from time to time, caused considerable damage in different English counties, sometimes appearing on the dicotyledonous leaves in the early summer as well as on the full-grown leaves in the autumn; and now, for the first time in Shropshire, another insect foe, whose known antecedents imply the possibility of very serious mischief to the mangels, appears. The *Aphis rumicis*, Linn., popularly known as "black dolphin" in some districts, "collier" or "black smother-fly," is, I feel pretty sure, the species in question. The diagnosis of the Aphides in closely allied species is very difficult, and the absolute differentiation of *A. rumicis* and *A. atriplicis*, for instance, is especially so. However, I carefully compared a great number of these mangel Aphides with specimens on the beans in my own garden, and could see no difference between the two lots.

Mr. Buckton, the author of the valuable 'Monograph of British Aphides,' Ray Society, to whom I sent fresh specimens of the *Aphis* on some affected leaves, corroborated my identification. Miss Ormerod informs me that *A. papaveris* is mentioned by Kaltenbach as occurring on almost all kinds of plants, and especially on mangel; but I feel sure that *A. papaveris* is not the species I examined. The same lady also informs me that in the course of the year before last she received numerous specimens on mangels, which appeared to her to belong to *A. atriplicis*, Linn. It is not improbable therefore that the three species—*A. rumicis*, as noticed by myself, *A. papaveris*, as mentioned by Kaltenbach, and *A. atriplicis*, as examined by Miss Ormerod—are all occasional mangel pests.

Buckton says that *A. rumicis* is almost omnivorous; though its common food-plants are *Rumex crispus*, *Carduus lanceolatus*, and the stalks and top shoots of the broad-bean; it is also found on the flower-heads of the garden rhubarb and ivy-shoots, on *Polygonum persicaria*, *Borago officinalis*, *Digitalis purpurea*, and other plants. Mr. Buckton also informs us that in 1854 the ravages of this *Aphis* in the turnip-fields of Yorkshire were very marked, many hundred acres being utterly ruined. Now, one of the fields visited by me last

* See my paper in the 'Quarterly Journal of Microscopic Science' for 1863, where the female fly is figured and described for the first time.

autumn contained a crop of mangels and a crop of swedes; the former plants were covered with the conspicuous black *Aphis*-population, but the swedes were not attacked at all; even the row adjacent to the infected mangels was free from them. *Aphis brassicæ* occurred, but not *A. rumicis.* This fact would lead one to believe that the *Aphis* prefers mangels to swedes, and that probably it has a predilection for plants either of the same species or belonging to the same natural order. In the absence of an abundant supply of their favourite food the insects take to other food-plants readily accessible. The question of its almost omnivorous habits may be to some extent determined by the absence of its favourite food from certain localities.

The affected leaves presented on their under surfaces large black masses of *Aphis*-life, almost every leaf of the plant was sometimes covered, the result being that the whole showed a sickly yellow hue, the underside of the leaves being deeply puckered and distorted; after a time the leaves drooped and withered. For some time the damage continued, the apterous viviparous females being excessively prolific and producing their young larvæ in prodigious numbers. I have counted as many as thirty larvæ in various stages of development in a single individual. One might occasionally see amongst these black *Aphis* masses some dried-up skins of the insect, the result of ichneumon-parasitism; but, on the whole, no marked beneficial result from insect-agency was apparent, and one began to fear for the mangel crops. Fortunately, however, an effective aid suddenly came to the rescue in the presence of a microscopic fungus of some kind which completely covered the Aphides. About the beginning of October I noticed that these black *Aphis*-patches on the leaves contained a number of red or rust-coloured spots, which proved to be Aphides either in a moribund or dead state. The microscope revealed the presence of some fungus, which it was quite clear was plying its beneficial destructive agency most vigorously on the *Aphis*-groups.

I placed some infected aphides under a glass with healthy specimens from my garden-beans, and in a short time these became similarly covered with the same red-coloured fungoid growth. The niggers took the scarlet fever and died. On submitting this fungoid growth to the microscope, I could detect numerous conidia amongst the filaments, but could not quite satisfy myself as to their origin and mode of attachment. About the end of October another phenomenon presented itself: the red aphides turned a dull green both on the plants in the fields and on the leaves I had under

observation in my study. The aphides had already succumbed to the red fungus; what was the green growth which supervened? Was it the same fungus under a different aspect and in a more complete stage of development, or was it another fungus altogether? Were these two growths—the preliminary rusty-red one and the subsequent green one—genetically related to each other, or were they distinct plants? With a view to determine this question I sent specimens to my friend Mr. William Phillips, of Shrewsbury, a gentleman who has paid great attention to mycological subjects, and who is one of our most painstaking and cautious observers.

The occurrence of fungoid growth on aphides is mentioned by Buckton (Brit. Aphides, ii. p. 18, iv. p. 184), and has been noticed by several investigators. The first-named writer says that on the leaves of peach-trees in summer "there are often to be found isolated specimens of *Rhopalosiphon dianthi* whose bodies have been entirely destroyed by what would appear to be a species of *Penicillium*. The outer surface of the body to the eye appears like the pile of reddish velvet, which, under a high magnifying-power, resolves itself into a mass of jointed threads. On cutting into the body of such an aphis, the adipose matter, usually so abundant, appears to have undergone a saccharine degradation."

This fungus may prove to belong to the genus *Entomophthora*, and to be identical with that of which Mr. Phillips gives an account in the following letter:—

"*Fungus on Aphides.*

"Two conditions of the dead bodies of the aphides on mangel-leaves you kindly sent me were noticeable—the one a rusty red, the other a dull green colour—both produced by the growth of one or more, probably two, species of fungi. It was not possible to say at first sight whether the red preceded or followed the green growth, or whether the two were genetically related. On placing a few bodies covered by the red growth under a bell-glass in a damp atmosphere they became covered in about two days by the green growth, whereas the green so treated did not change to red. It is very difficult to determine the question of relationship between fungi thus associated, and all I was able to do in the time at my command was to examine the morphology of these fungi with a view of ascertaining their relationship to allied species already described. The result may be given in a few words.

"Those insects which were killed by the red fungus had died in a standing position with the legs extended (Pl. III. A, fig. 1) or, more rarely, folded beneath the body. The bodies of some were only partially discoloured by the little patches of the fungus, while others were completely covered, except the legs, so as to conceal all markings of the body. In this last condition they are considerably enlarged, but retain their general outline, and are firm and tough under the knife. When viewed with a 1-inch object-glass the fungus is seen as a closely-packed layer of glistening reddish-brown particles, which, when recourse is had to the higher power of a quarter of an inch, are resolved into elliptic or obovate cells supported on subcylindrical elongated cells issuing from the inside of the insect's body (figs. 8–12). Dividing one of the bodies by a longitudinal cut, the viscera are seen to be absorbed and replaced by a compact mass of fungus-threads of the same colour as those on the surface. Examining this mass under a quarter-inch object-glass, it is seen to be made up of more or less elongated tubular cells (figs. 2–7), varying in diameter from ·005 to ·015 millim., and in length from ·05 to ·15 millim.; they are irregularly bent, sometimes branched (fig. 5), and occasionally septate (fig. 7); the interior of the cells is filled with coarsely granular protoplasm, with numerous large vacuoles. The ends of these cells force themselves through the body of the insect to the outside, and bear conidia on their summits, which are formed by abstriction (figs. 8–12). If these conidia are detached from the conidiophore before they are mature, as happens under the pressure of the covering-glass, the base is truncate (fig. 13, *a*, *a*, *a*), but if allowed to mature they are elliptic or obovate (fig. 13, *b*, *b*); they are occasionally in a later stage observed throwing out germ-tubes at either end (fig. 13, *c*, *c*).

"From the above brief description it will be at once apparent that this rusty-red fungus causing the destruction of the aphides is a close ally of the well-known *Empusa muscæ*, Cohn, which attacks and kills the common house-fly. Fresenius has created the genus *Entomophthora* * for the reception of these insect-killing species, in which Dr. Winter, in his new edition of Rabenhorst's 'Kryptogamen Flora,' includes ten species. One of these, *E. aphidis*, Hoffm.†, is found on an aphis on *Cornus sanguinea*; but this is essentially different from the one found on mangel, as I have been able to satisfy myself by the examination of an authentic specimen kindly

* Bot. Zeitung, 1856, p. 883.

† Fresenius, "Ueber die Pilzgattung *Entomophthora*," in Abhandl. der Senckenb. natur. Gesellsch. Band ii. p. 208, t. ix. figs. 59–67.

lent me by Dr. Cooke. I was not fortunate enough to find the resting-spore in the mangel aphis; but should it appear again this autumn I may be more successful. The species may be called pro tem. *Entomophthora ferruginea*, n. s.

"The dull green fungus which at a later stage covers the dead bodies of the aphides and entirely obscures, though it does not destroy, the above-described *Entomophthora*, bears a general resemblance to *Penicillium glaucum* to the naked eye (Pl. III. B, fig. 1). This also sends its more delicate mycelial threads through the mummified aphides, appearing at length on the outer surface as erect dendritic conidiophores (fig. 2). It can be best traced in the legs of the insect, which are usually unaffected by the *Entomophthora*. After traversing the interior of the leg it issues from between the joints (fig. 3), throwing up a number of slender septate threads, about ·5 millim. high and ·004 millim. broad, which form a fasciculate head of dichotomously branching chains of conidia, which are cylindrical, rounded at the ends, and variable in length. This appears to agree with *Penicillium cladosporioides*, Fresen. Beitr. t. iii. figs. 23–28."

Since the above was in type, Mr. Phillips informs me that he has not seen *Entomophthora Planchoniana*, described by Prof. Max Cornu, of Paris, which also grows on aphides, and should be compared with the above (*vide* 'Bulletin de la Société Bot. de France,' 1873, p. 189). I observe also that Miss Ormerod records, as an insect injurious to mangels, the beetle *Steropus madidus* (Royal Agricult. Soc. Report, April 1886, p. 311), "previously believed to be only carnivorous." As this insect is one of the Harpalidæ, some species of which are known to be herbivorous (see Westwood's 'Mod. Class. of Insects," i. p. 63), it is quite probable that we may hear more of this little beetle as an enemy to mangel crops.

W. Houghton.

EXPLANATION OF PLATE III.

A.

Fig. 1. An aphis killed by *Entomophthora ferruginea*, the natural size.

Figs. 2–7. Mycelial cells found in the interior of the body of the aphis. Magnified about 350 times.

Figs. 8–12. Mycelial cells, bearing on their summits the conidia in various stages of formation by abstriction.

Fig. 13. Conidia in different conditions. *a, a, a, a*, showing the truncate base by which they were attached to the conidiophores; *b, b*, conidia with the base rounded off; *c, c*, others throwing out germ-tubes from both ends.

B.

Fig. 1. An aphis previously attacked and killed by the *Entomophthora* now invaded by a *Penicillium.* Natural size.

Fig. 2. The leg of an aphis out of which the *Penicillium* is growing, mostly at the joints. Magnified 70 times.

Fig. 3. *Penicillium cladosporioides,* Fresen., removed from the insect and placed under a higher power, showing the form of growth. Magnified 350 times.

Figs. 4′, 4″. Conidia of various sizes, some of those on the right showing minute side-growths.

II.—*Description of a Moth of the Genus* Milionia *from Borneo.* By A. G. Butler, F.L.S. &c.

Early in the present year the Museum purchased a small series of Lepidoptera from Borneo, amongst which was a *Milionia*, allied to *M. zonea*, and which I fully believed, at the time when I selected it, to be the Burmese *M. pyrozonis.* On comparison with the two species from Darjiling and Tenasserim I find it to be intermediate in character, and to be the male of an insect which we have long had unnamed in the collection, on account of the indefinite character of the locality received with it—" E. India." I propose to call this species *M. Sharpei*, in honour of our ornithologist Mr. R. B. Sharpe, through whose efforts the collection was submitted to us.

Milionia Sharpei, sp. n.

Size and coloration of *M. zonea*, of Darjiling, the wings being velvety blue-black with metallic cobalt-blue streaks upon the veins at the base; the primaries with an oblique bright orange belt and the secondaries with the outer third of the same colour, with five large oval black spots immediately before the fringe. Body dull purplish black, the head, collar, and tegulæ spotted and streaked with metallic blue-green; the abdominal segments edged with metallic blue; anal tuft grey; legs with their upper surfaces brilliant metallic blue. Expanse of wings 65 millim.

♂, Borneo; ♀, " E. India." Coll. B. M.

From *M. zonea* this species may readily be distinguished by the belt of the primaries, which is quite a third narrower towards its inferior extremity and more arched throughout, and from both *M. zonea* and *M. pyrozonis* by the narrower external orange area to the secondaries, upon which the spots are oval rather than fusiform, and by the dark grey instead of stramineous or dull white colour of the anal tuft. In *M. pyrozonis* also the colouring of the orange belts is considerably redder; but this naturally alters with age.

III.—*On some new or imperfectly-known Species of Stromatoporoids.* By H. Alleyne Nicholson, M.D., D.Sc., Regius Professor of Natural History in the University of Aberdeen.—Part II.

[Plates I. & II.]

Stromatoporella curiosa, Barg., sp.
(Pl. I. figs. 1–3.)

Stromatopora polymorpha, Goldfuss, Petref. Germ. pl. lxiv. figs. 8 *a*, 8 *c*, & 8 *d* (cæt. excl.) (1826).
Stromatopora curiosa, Bargatzky, Die Stromatoporen des rheinischen Devons, p. 55 (1881).
? *Stromatopora nulliporoides*, Nicholson, Report on the Palæontology of the Province of Ontario, p. 78 (1875).
? *Cœnostroma incrustans*, Hall & Whitfield, Twenty-third Annual Report on the State Cabinet, p. 227, pl. ix. fig. 3 (1873).

Cœnosteum encrusting, thin, attached by the whole of the inferior surface to some foreign body, and usually developing externally numerous irregular pointed eminences, at the extremities of which the astrorhizæ open. Surface usually covered with minute rounded tubercles, the apices of which may be perforated, and also exhibiting branched astrorhizal canals; in other cases part or the whole of the surface may be covered by a thin calcareous membrane, which exhibits few or no apertures of any kind. As regards internal structure the skeleton-fibre is minutely porous, and the skeletal tissue is of the imperfectly reticulate type. The concentric laminæ are thick and well-marked, often with a median clear line in each (as seen in vertical section), and they are placed from $\frac{1}{4}$ to $\frac{1}{3}$ millim. apart. The transversely divided ends of the radial pillars can be more or less extensively recognized as distinct structures in tangential sections. The astrorhizæ are furnished with vertical axial canals, and astrorhizal tabulæ may be sparingly present. Definite zoöidal tubes are not recognizable.

Obs. This is a typical example of an encrusting and parasitic Stromatoporoid. It envelops Rugose corals or other organisms, and forms crusts varying in thickness from less than a millimetre up to 5 or 6 millim. One of its most characteristic and conspicuous external features is the fact that the exterior is more or less extensively covered with pointed conical eminences (Pl. I. fig. 1), which may be imperforate, or which may terminate in an aperture corresponding with the centre of one of the astrorhizal systems. These eminences or "mamelons" may be comparatively large, sometimes more

than a centimetre in height, in which case they are comparatively few in number. More usually they are smaller, perhaps 2 or 3 millim. in height, and in this case they are numerous. When well developed each of these pointed eminences consists of concentrically laminated tissue traversed centrally by the axial canal of an astrorhizal system, and having the external opening of the same at its apex, while the astrorhizal twigs run down its sides externally.

The surface presents curious and very puzzling variations in different examples, or in different regions of the same specimen. Sometimes the whole, or a part only, of the surface is covered with minute rounded or elongated tubercles, which sometimes coalesce into vermiculate ridges, and which may have their apices perforated with minute circular apertures. This seems to be the normal condition of the surface. In many specimens, however, this granulated surface is extensively, or completely, concealed from view by the development of a delicate smooth calcareous pellicle or membrane. This external membrane may pass unbrokenly over the mamelons as well as over the general surface; but commonly the apices of the mamelons show a few small apertures or the single larger opening of an astrorhizal canal. In this latter case the appearances presented remind one of the general surface of *Distichopora* at points where ampullæ are developed.

As regards internal structure, the general appearances presented by tangential and vertical sections (Pl. I. figs. 2 and 3) are very similar to those of corresponding sections of *Stromatoporella eifeliensis*, Nich., and need not be more minutely discussed here. The present species is distinguished from *S. eifeliensis*, as from the other related species of *Stromatoporella*, by its uniformly encrusting habit, the development of pointed mamelons, and the characters of its surface. It does not appear to differ, to any marked extent, from an encrusting Stromatoporoid from the Hamilton formation of North America, to which I gave the name of *Stromatopora nulliporoides* (*loc. cit. supra*); and the latter name will therefore probably have to be regarded as a synonym. It also seems to me very probable that the form described by Professors Hall and Whitfield, from the Chemung group of North America, under the name of *Cœnostroma incrustans* (*loc. cit. supra*) will prove to be really identical with the present species.

Formation and Locality. Common in the Middle Devonian formation of Büchel (in the Paffrath district). I have also found it at Paffrath, and, more rarely, at Gerolstein and Bärendorf (Hillesheim) in the Eifel.

Stromatoporella granulata, Nich.

Stromatopora granulata, Nicholson, Ann. & Mag. Nat. Hist. ser. 4, vol. xii. p. 94, pl. iv. figs. 3, 3 *a* (1873).

Cœnosteum forming laminar expansions, attached basally by a peduncle, and having the rest of the lower surface covered by concentrically striated and wrinkled epitheca. The thickness of the cœnosteum varies from less than 2 millim. up to 2–3 centim. The surface shows a variable number of low rounded or conical eminences or "mamelons," the apices of which are usually perforated, each with a single circular opening representing the axial canal of one of the astrorhizal systems. From the apices of the mamelons radiate more or less conspicuous astrorhizal gutters, and the general surface is covered with close-set tubercles of various sizes, the smaller of these being imperforate, while the larger ones are perforated at their apices by distinct circular apertures. In places the tubercles coalesce into vermiculate ridges. Parts of the surface may be covered with a thin calcareous membrane, perforated by the apertures of the larger tubercles above spoken of.

As regards internal structure the skeleton-fibre is minutely porous, and the skeletal tissue is of the incompletely reticulate type. Vertical sections show well-developed concentric laminæ, each often with a median clear line, the radial pillars being thick and the interlaminar spaces from $\frac{1}{6}$ to $\frac{1}{4}$ millim. in height. Imperfect zoöidal tubes, with few tabulæ, are often recognizable. In tangential sections the transversely divided ends of the radial pillars are seen, each often in the form of a ring enclosing a central circular space. It is the free upper ends of these which form the perforated tubercles on the surface. The intervals between the cut ends of the radial pillars are often crossed by delicate partitions, indicating the presence of astrorhizal tabulæ.

Obs. *S. granulata* is the type-species of the genus *Stromatoporella*, and I have elsewhere figured its minute structure with some fulness ('Monograph Brit. Stromatoporoids,' part i. pl. i. figs. 14, 15, pl. iv. fig. 6, and pl. vii. figs. 5, 6). As I have not repeated these figures here, it is not necessary to discuss the minute characters of the species in greater detail on the present occasion. *S. granulata* is undoubtedly very nearly related to *S. eifeliensis*, Nich., but seems to be specifically distinct. As compared with the latter species it is most readily distinguished by the much smaller development of the astrorhizal system, and by the conspicuous presence of hollow radial pillars which appear on the surface as large

perforated tubercles, and which are clearly recognizable in tangential sections. The interlaminar spaces are also wider, and the general tissue is of a coarser type than in *S. eifeliensis*; while the ramified tubulation of the skeleton-fibre in the latter is represented by a finely porous structure. Lastly, *S. eifeliensis* is an almost constantly encrusting type, while I have never observed a similar habit of growth in *S. granulata.*

Formation and Locality. Not uncommon in the Hamilton formation of Arkona, Ontario; also in the Corniferous Limestone of Port Colborne and other localities in Western Ontario.

Labechia conferta, Lonsd., sp.

Monticularia conferta, Lonsdale, in Murchison, Sil. Syst. p. 688, pl. xvi. fig. 5 (1839).

Labecheia conferta, Milne-Edwards & Jules Haime, Pol. Foss. des Terr. Pal. p. 280 (1851), and Mon. Brit. Foss. Cor. p. 269, pl. lxii. figs. 6–6*c* (1855).

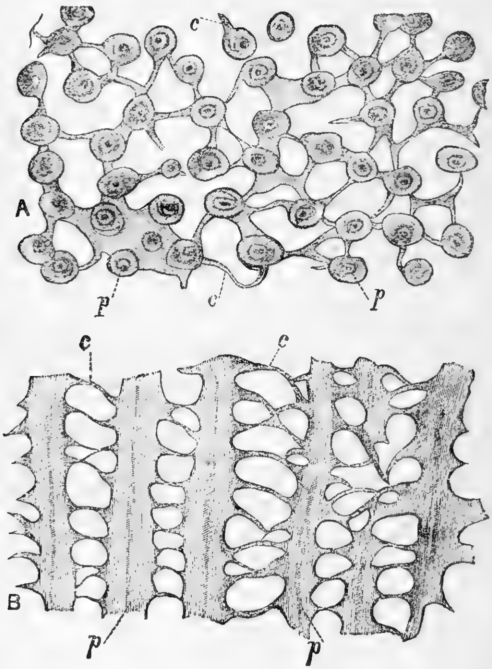
Cœnosteum usually in the form of a laminar expansion of variable thickness, attached by a basal peduncle, and having the rest of the lower surface covered by a concentrically wrinkled epitheca. Upper surface without monticules, covered with prominent, rounded or elongated, often conical tubercles, the apices of which may be imperforate, or which exhibit a minute circular summit-aperture. Often the tubercles become coalescent to a greater or less extent, and give rise to vermiculate ridges. The surface between the tubercles is smooth, and no astrorhizal grooves are developed.

In internal structure the cœnosteum consists of stout, circular or oval, radial pillars, which have a diameter of $\frac{1}{4}$ to $\frac{1}{3}$ millim., and terminate upwards in pointed extremities, each being traversed by a central canal. The pillars give rise to radiating "arms" or plates, which unite with one another in such a manner that the entire space between the pillars becomes filled with a tissue of calcareous vesicles, the convexities of which are directed upwards.

Obs. This well-known species occurs typically in the form of laminar expansions with an epithecate base and peduncle of attachment, but in some instances an encrusting habit of growth is observable. Young examples may be only 2 or 3 centim. in diameter, and 1 millim. in thickness; but old specimens may be of greater size, perhaps a foot in diameter, and may reach a thickness of 2–3 centim. A single specimen often consists of two or more superposed colonies. The surface differs from that of many Stromatoporoids in the complete absence of "mamelons," and of any indications of an astrorhizal system, being covered throughout with prominent

tubercles, which may be about $\frac{1}{3}$ millim. in height, and about the same diameter at their base. The tubercles may be placed about $\frac{1}{3}$ to $\frac{1}{4}$ millim. apart, or may be in contact, often coalescing in sinuous rows. The apices of the tubercles may be simply rounded or pointed, and may be apparently imperforate. In other cases a distinct circular aperture may be detected at the apex of a pillar, though it is not clear that this is not the result of weathering.

Vertical sections (woodcut, fig. B) show that the cœnosteum is essentially composed of very stout radial pillars,



Sections of *Labechia conferta*, Lonsd., sp., enlarged twelve times. Wenlock Limestone, Ironbridge :—A. Tangential section. B. Vertical section. *p p* radial pillars ; *c c*, connecting processes or "arms."

which spring from the basal epitheca and are continued to the upper surface, where they terminate in the prominent tubercles above spoken of. The interspaces between the pillars are occupied by a vesicular tissue formed by the coalescence of connecting processes, or "arms," given out from the pillars, the convexities of the vesicles being turned towards the upper surface.

Tangential sections (woodcut, fig. A) show that the radial pillars are hollow, each being traversed by a well-marked axial canal. The tissue forming the periphery of the pillars is composed of very delicate laminæ which surround the axial canal concentrically, and which often show a minute cribriform structure. The connecting processes spring from this tissue, and can commonly be followed in vertical sections for a considerable distance into the substance of the pillars. Tangential sections further exhibit irregular dark lines connecting the transversely divided tangential pillars; these lines are the cut edges of the vesicular plates or processes which fill the intervals between the pillars.

There is, apparently, a complete absence of definite zoöidal tubes or surface apertures, and the "concentric laminæ" of the ordinary Stromatoporoids are represented solely by the vesicular tissue which unites the pillars together.

Formation and Locality. Abundant in the Wenlock Limestone of Britain (Ironbridge, Dudley, Dormington, Longhope, &c.). I have also specimens from the Wenlock Limestone of Gotland (presented to me by Prof. Lindström); but I have not obtained the species in the Silurian deposits of Esthonia or Oesel.

Labechia ohioensis, Nich. (Pl. II. figs. 1 and 2.)

Labechia ohioensis, Nicholson, Mon. Brit. Strom. p. 32, footnote, pl. ii. figs. 1 & 2 (1885).
Labechia montifera, Ulrich, Contributions to American Palæontology, vol. i. p. 33, pl. ii. figs. 9, 9*a* (1886).

Cœnosteum sometimes laminar and pedunculate (?), often encrusting foreign bodies. Upper surface sometimes smooth, but more commonly with small conical "mamelons," covered throughout with minute rounded or pointed tubercles. Radial pillars about $\frac{1}{6}$ millim. in diameter, and placed at distances of from $\frac{1}{4}$ to $\frac{1}{3}$ millim. apart. The radial pillars are mostly more or less angulated, and sometimes exhibit distinct traces of axial canals. The interspaces between the pillars are occupied by delicate vesicular tissue formed of minute vesicles, the convexities of which are directed towards the surface.

Obs. In general structure this well-marked species resembles *L. conferta*, Lonsd., sp. It is distinguished from this, however, by the much smaller size of the radial pillars, and the correspondingly smaller and less prominent tubercles upon the surface. Moreover, the pillars commonly appear angulated or stellate in cross-section instead of being round or oval. Lastly, the vesicles of the interstitial tissue are much smaller and more delicate, and are developed in proportionally greater quantity than is the case in *L. conferta* (Pl. II. fig. 1).

In minute structure *L. ohioensis* presents nothing very special. Owing apparently to imperfect preservation the axial canals of the pillars are only occasionally recognizable; but I have seen traces of a cribriform structure of the tissue of the pillars. In the specimen which I figured originally the actual skeleton of the fossil has been replaced by calcite, all the cavities of the cœnosteum being filled with matrix. In the specimen here figured (for which I am indebted to the kindness of my friend Mr. Arthur H. Foord) the skeleton is preserved in the normal manner.

Mr. Foord has also drawn my attention to the fact that some of the appearances which he described (Contrib. to the Micro-Pal. of the Cambro-Silurian Rocks of Canada, p. 25, 1883) as characterizing *Tetradium huronense*, Bill., sp., are really due to the fact that the specimens of this coral which he examined were covered with a crust of *Labechia ohioensis.* Thus the granules or tubercles described as covering the surface of *Tetradium huronense* are referable to the investing Stromatoporoid and not to the coral itself.

While these pages have been going through the press I have received from Mr. E. O. Ulrich a copy of his 'Contributions to American Palæontology' (vol. i. no. 1, May 1, 1886), in which a species of *Labechia* is described from the Cincinnati formation under the name of *L. montifera.* Mr. Ulrich's description and figures seem to render it certain that the species named &c. is identical with the one to which I had previously applied the name of *L. ohioensis.* In all essential points the internal structure of these is the same, though Mr. Ulrich's specimens seem to have been in some respects in a better state of preservation than those which have come under my notice. According to Mr. Ulrich the species occurs in the upper part of the Cincinnati group in Ohio and Indiana.

Formation and Locality. Cincinnati group, Waynesville, Ohio (*coll. H. A. Nicholson*); Hudson-River formation, Cape Smythe, Lake Huron (*coll. A. H. Foord*).

Labechia canadensis, Nich. & Murie, sp.
(Pl. II. fig. 5.)

Stromatocerium canadense, Nicholson & Murie, Journ. Linn. Soc., Zool. vol. xiv. p. 223, pl. iii. figs. 9, 10 (1878).

Labechia canadensis, Nicholson, Mon. Brit. Stromatoporoids, pl. ii. figs. 3–5.

Cœnosteum sometimes massive, sometimes composed of thick laminæ with a basal epitheca. Surface imperfectly known, but apparently possessing irregular tubercles and conical mamelons. Radial pillars large and irregularly developed. The vesicular tissue between the pillars is also very

irregularly developed, the vesicles being sometimes of moderate dimensions, but being at other places of large size and irregular form. The vesicles have their convexities turned upwards, and the radial pillars terminate upwards in pointed extremities.

Obs. All the examples of this species which I have examined are in a highly mineralized condition, and are not in a state to allow of the satisfactory working out of minute structural details. That the specimens are rightly referable to the genus *Labechia* is, however, clear, and there can also be no doubt as to the distinctness of the species. Many of the specimens which I have collected, both from America and Russia, have the skeleton replaced by calcite; but I have here figured a vertical section of a Russian example in which the skeleton is preserved in the normal manner. The species is most nearly allied to *L. conferta*, Lonsd., but is sufficiently distinguished from it by the much more irregular development of the radial pillars and the correspondingly irregular development, as regards both size and shape, of the interstitial vesicles.

Formation and Locality. Ordovician formation (Trenton Limestone), Peterborough, Ontario. Also in the same formation (Upper "Jewesche Schichten" or "Wassalem beds"), Saak, Esthonia. [It is interesting to notice that another Trenton fossil, viz. *Solenopora compacta*, Bill., sp., is also common at Saak.]

Labechia serotina, Nich. (Pl. II. figs. 3 and 4.)

Labechia serotina, Nicholson, Mon. Brit. Stromatoporoids, p. 45, woodcut, fig. 4 (1885) (figured but not described).

General form and surface of the cœnosteum unknown. In internal structure the skeleton is composed of cylindrical radial pillars, which have a diameter of about $\frac{1}{6}$ millim., and which are traversed by large axial canals. The canals of the pillars are provided with curved internal partitions, which run transversely to the canal, and have their convexities turned upwards. The pillars are very rarely isolated, but are mostly in contact laterally in such a way that they give rise to sinuous rows, forming a network of much the same pattern as that produced by the corallites of *Halysites escharoides*, Linn. The interspaces between the winding rows of pillars are crossed by delicate calcareous fibres or plates, which connect the pillars together, and which are only rarely and partially vesicular. These connecting plates are usually straight, and are only occasionally curved; hence they give to vertical sections the aspect of a tabulate coral.

Obs. The only example which I possess of this remarkable Stromatoporoid is a small polished fragment from the Devonian Limestone of Devonshire, which I purchased from Mr. Sclater, of Teignmouth. The structure of the skeleton differs so widely from that of the ordinary species of *Labechia* that it is unnecessary to compare it minutely with these. The characteristic features of *L. serotina* are the confluence of the radial pillars into a reticulation of sinuous rows, the large size of the axial canals, the presence of curved transverse partitions in the interior of the axial canals of the pillars, and the fact that the interstitial tissue is composed of straight horizontal plates, which only rarely become vesicular, and then only to a very limited extent.

I may mention that there exists in the Devonian limestones of Devonshire another form of *Labechia*, the structure of which accords essentially with that of the normal species of the genus. I have not, however, as yet completely investigated this form, and shall therefore defer its description to a later time.

Formation and Locality. Middle Devonian of Devonshire. The specimen is in a red limestone, and is probably from the neighbourhood of Torquay.

Labechia? Schmidtii, Nich. (Pl. II. figs. 6–8.)

Labechia conferta, Fr. Schmidt, Silur. Form. von Ehstland &c. p. 230 (1858).
Labechia conferta, Lindström, Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. p. 4 (1876).
Labechia conferta ("Oesel'sche Form"), Dybowski, Die Chætetiden der ostbaltischen Silur-Formation, p. 55, pl. iii. figs. 7, 7 *a* (1877).
Labechia conferta, Ferd. Roemer, Lethæa Palæozoica, p. 543, fig. 126 (1883).

Cœnosteum in the form of laminar expansions, attached by a basal peduncle, and having the rest of the lower surface covered by a concentrically-striated epitheca. The cœnosteum may be of very considerable size, and its thickness varies from a couple of millimetres up to perhaps two centimetres. The upper surface is in many cases studded with very prominent and large tubercles, which are placed close together in oblique lines, but which rarely touch or become confluent. The free extremities of the tubercles are in some specimens round, in others pointed, and they mostly show no openings at their apices. In some cases there is the appearance of apical apertures; but it seems probable that this is only the result of wearing down of the surface. In many specimens the whole or a large part of the surface may be covered with a thin calcareous membrane, which passes over the summits of

the tubercles, either completely concealing these or only allowing their ends to be faintly discerned.

As regards internal structure, the entire cœnosteum appears to be composed of approximated parallel horizontal laminæ, which are bent into a system of close-set conical elevations, which, in the last-formed layer, give rise to the surface-tubercles. The structures representative of the radial pillars are thus composed of the successively superimposed upward bendings of the horizontal laminæ; and the interspaces between these are occupied by the same laminæ bent downwards and closely approximated to one another.

Obs. The structure of this form has been well described by Lindström and Dybowski. From the description given above and from the accompanying figures (Pl. II. figs. 7, 8) it will be evident that, supposing the structure to be really what it *appears* to be, we have to deal with a type exceedingly different from *Labechia conferta*, Lonsd., though the superficial resemblances between the two are very striking. On this point Dybowski is quite clear, and he speaks of this type as the "Oesel'sche Form" of *Labechia conferta*. The first specimen which I examined was one kindly sent me by Prof. Ferd. Roemer, and as I found it to be highly crystallized I thought it possible that it might be generically identical with *Labechia conferta*, Lonsd., and that its apparently very different internal structure might be only the result of extreme mineralization (Mon. Brit. Strom. p. 83). Since then I have collected and examined an extensive series of specimens from the Silurian rocks of Oesel; and I have come to the conclusion that the present form is unquestionably specifically distinct from *L. conferta*, Lonsd., and that it is very doubtful indeed if it can be referred to the genus *Labechia* at all.

All the specimens which I have seen are in a state of complete crystallization internally, though the upper and under surfaces are excellently preserved. This mineralization has not obliterated the internal structure, though it may be assumed to have considerably obscured it. Tangential sections (Pl. II. fig. 7) exhibit rows of circular spaces, surrounded by a dark line, often exhibiting a dark central spot, and composed of more or less clearly recognizable concentric laminæ surrounding this central spot. These circular spaces are about ½ millim. in diameter, and clearly correspond with the cut ends of the radial pillars, as seen in tangential sections of *L. conferta*, Lonsd. The dark central spot also probably indicates an axial canal. On the other hand, the intervals between these circular spaces are occupied by a dense brown tissue belonging to the cœnosteum itself, whereas in *L. conferta*

the corresponding intervals are filled with clear calcite, crossed here and there by the cut edges of the interstitial vesicles.

In vertical sections (Pl. II. fig. 8) the differences between *L.? Schmidtii* and *L. conferta* are still more striking. Instead of seeing the well-marked radial pillars separated by intervals filled with lenticular vesicles, as we should do in the latter species, we now see a uniformly brown section, in which there are no recognizable spaces filled with calcite, and no vesicular tissue. All that the vertical section exhibits in *L.? Schmidtii* is a series of sharply undulated and exceedingly thin lamellæ, which appear to be in close apposition. The upward bendings of these lamellæ correspond with the radial pillars, and the downward bendings correspond with the intervals between these. Periodically a thicker and stronger lamella than the rest is produced, indicating a pause in the growth of the organism. The whole texture of the section is also more or less obviously crystalline, though not more so than one often sees in sections of Echinodermal structures.

It need not be doubted that the peculiarities of these sections are in part the result of crystallization and secondary change; but I have come to the conclusion that this is not sufficient to account for the greater portion of the remarkable internal structure of this species. More particularly I have come to the conclusion that no amount of crystallization could account for the absence of the interstitial vesicular tissue which fills in the intervals between the pillars in the normal forms of *Labechia*, supposing this tissue ever to have existed in the Oesel form. I have, in fact, examined thin sections of specimens of *L. conferta*, Lonsd., from Dudley, in a condition of intense crystallization, and I have neither observed any appearances in these at all comparable with those seen in the Russian examples, nor have I ever failed to recognize in them the radial pillars and interstitial vesicular tissue.

If, however, the form now under consideration be really destitute of interstitial vesicular tissue, and if it be really composed of sharply undulated and closely approximated calcareous laminæ, then it obviously can no longer find a place in the genus *Labechia*, E. & H. The form which it most closely resembles is one which I described from the Niagara Limestone of North America under the name of *Dictyostroma undulatum* (Pal. of Ohio, vol. ii. p. 254, pl. xxiv. fig. 6, 1875). The surface, when somewhat exfoliated (Pl. II. fig. 6), has, in particular, a close resemblance to what is seen in *Dictyostroma undulatum*. Unfortunately, the microscopic structure of the Ohio species has not yet been investigated, and the genus *Dictyostroma* cannot therefore be regarded as

satisfactorily established. In the meantime, however, I am disposed to think that these two forms are congeneric, and that the structure of the genus *Dictyostroma*, Nich., will therefore prove to be that which I have here described as characterizing *Labechia? Schmidtii.*

In any case, even supposing that the present type were left in the genus *Labechia*, it would still be clearly separated as a *species* from *L. conferta*, Lonsd. Thus, apart from the presumed want of continuous radial pillars and interstitial vesicular tissue, the surface-tubercles of *L.? Schmidtii* are much more prominent and much larger than they are in *L. conferta*, Lonsd., and they rarely, or never to any extent, coalesce, as they so commonly do in the latter. Again, I have never observed in *L. conferta* any trace of the singular surface-pellicle which so commonly spreads over the last-formed layer of tubercles in the Russian form. I have therefore no difficulty in agreeing with Dybowski as to the specific distinctness of the latter, and I have named it after Magister Friedrich Schmidt, by whom it was originally discovered in the Silurian rocks of Oesel.

Formation and Locality. Common in the Silurian formation (Upper Oesel beds) of Hoheneichen, Oesel. I have also found it at Kattri-pank and at Lode, near Arensburg.

Rosenella dentata, Rosen, sp. (Pl. I. figs. 4 and 5.)

Stromatopora dentata, Rosen, Ueber die Natur der Stromatoporen, p. 75, pl. x. figs. 1–3 (1867).
Labechia dentata, Ferd. Roemer, Lethæa Palæozoica, p. 543 (1883).

Cœnosteum massive; surface unknown. The skeleton is composed of undulating concentric laminæ, which unite to form elongated vesicles, the convexities of which point upwards. The radial pillars are rudimentary and are represented only by close-set conical tubercles, which cover the upper convex surface of the vesicles, very rarely reaching the under surface of the lamina next above. The laminæ are not specially thickened and are mostly placed at intervals of $\frac{1}{4}$ to $\frac{1}{5}$ millim. apart, the vesicles generally being from 1 to 2 millim. in greatest length. Here and there, however, are found irregular spaces, often apparently periodically produced, in which the vesicles are of considerably larger size, and the laminæ therefore further apart.

Obs. This species is a characteristic example of the genus *Rosenella*, Nich.*. Vertical sections exhibit the elongated

* The genus *Rosenella* was founded by me (Mon. Brit. Stromatoporoids, p. 84, 1885) for forms which differ from *Labechia* in the fact that the radial pillars are reduced to tubercles, covering the upper surfaces of comparatively large lenticular vesicles.

lenticular vesicles of which the entire cœnosteum is composed, and which bear on their upper surfaces prominent, pointed, and close-set tubercles (Pl. I. fig. 4). Tangential sections (Pl. I. fig. 5) exhibit the transversely-divided ends of the tubercles or the irregularly-cut edges of the vesicles.

The species is structurally very similar to *Rosenella macrocystis*, Nich., from the Wenlock Limestone of Gotland, but is separated by the much smaller size of the vesicles. I have examined the original specimens upon which von Rosen founded the species, and I have also collected others myself; but I have never seen any example satisfactorily exhibiting the form of the cœnosteum or its mode of growth. The species was, however, evidently of large size and apparently non-encrusting.

Formation and Locality. "Zone of *Pentamerus esthonus*" (Silurian), Kattentack, Esthonia. Rosen's type specimen is from St. Johannis, in Oesel.

Rosenella macrocystis, Nich. (Pl. I. fig. 8.)

Rosenella macrocystis, Nicholson, Mon. Brit. Strom. p. 84, pl. vii. figs. 12 and 13 (1885). (Figured without description.)

Cœnosteum laminar, with a basal peduncle of attachment and a concentrically-wrinkled epitheca. Surface flat, without "mamelons," showing no astrorhizal grooves, and covered uniformly with minute, extremely close-set granules or tubercles. The cœnosteum is composed of approximately horizontal plates, which are so undulated or bent as to give rise to a tissue of elongated and greatly flattened vesicles of variable sizes, the larger ones being commonly from 5 to 15 millim. in length. Each lamina has its upper surface covered with close-set minute tubercles, which fall short of the lamina next above. Tangential sections show the cut ends of the tubercles or the irregularly divided edges of the undulating laminæ.

Obs. In general structure this species closely resembles *R. dentata*, Rosen. It is, however, sufficiently distinguished from this by the much more minute size of the tubercles which cover the upper surfaces of the laminæ, and by the much larger size of the vesicles which make up the whole cœnosteum. It is, moreover, a laminar form with an epitheca, whereas *R. dentata* would rather appear to have grown in large masses.

I have only seen a single specimen of *R. macrocystis*, which was collected in Gotland by Dr. George J. Hinde, who was good enough to submit it to me for examination. In

this specimen, which is only a fragment, the cœnosteum would appear to have been at least 4 inches wide and about ½ inch thick in the centre.

Formation and Locality. Wenlock Limestone, Wisby, Gotland (*coll. Dr. George J. Hinde*).

Rosenella pachyphylla, Nich. (Pl. I. figs. 6 and 7.)

Cœnosteum apparently massive, composed of undulated laminæ, which unite to form a tissue of elongated vesicles of very varying sizes, the larger ones being from 5 to 15 millim. or more in length. The upper surfaces of the laminæ are covered with exceedingly minute miliary granules or tubercles. The laminæ vary much in thickness, many of them being from ½ to 1 millim. thick. The thicker laminæ have a peculiar tubulated structure, being traversed by minute irregular canals, which penetrate them vertically, and thus place successive vesicles in communication. These tubuli are seen in vertical sections (Pl. I. fig. 6) crossing the laminæ at right angles. In tangential sections (Pl. I. fig. 7) the tubuli are seen in places where the section happens to correspond with one of the laminæ in question as close-set rounded perforations in the substance of the lamina. These tubuli probably served to convey stolons of the cœnosarc, and, in the last layer of vesicles, for the lodgment of zooids.

Obs. The only specimen I have seen of this species is a fragment of a larger mass, and has a thickness of about 2 inches, indicating that the cœnosteum grew to a large size. Unfortunately neither the under nor the upper surface is satisfactorily preserved. The general structure of the skeleton conforms to that of *Rosenella dentata*, Rosen, and *R. macrocystis*, Nich.; but the present species is sufficiently separated from these by the exceedingly minute size of the tubercles covering the upper surface of the laminæ, and still more by the peculiar thickening and tubulation of many of the laminæ.

Formation and Locality. Silurian ("Zone of *Pentamerus esthonus*"), Kattentack, Esthonia.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. A specimen of *Stromatoporella curiosa*, Barg., sp., of the natural size, forming a crust upon a Rugose coral. Middle Devonian, Büchel (Paffrath district).

Fig. 2. Tangential section of the same, enlarged twelve times.

Fig. 3. Vertical section of the same, similarly enlarged.
Fig. 4. Vertical section of *Rosenella dentata*, Rosen, sp., enlarged twelve times. Silurian, Kattentack, Esthonia.
Fig. 5. Tangential section of the same, similarly enlarged.
Fig. 6. Vertical section of *Rosenella pachyphylla*, Nich., enlarged twelve times. Silurian, Kattentack, Esthonia.
Fig. 7. Tangential section of the same, similarly enlarged.
Fig. 8. Vertical section of *Rosenella macrocystis*, Nich., enlarged twelve times. Wenlock Limestone, Gotland.

Plate II.

Fig. 1. Vertical section of *Labechia ohioensis*, Nich., enlarged twelve times. Ordovician (Hudson-River Formation), Cape Smythe, Lake Huron.
Fig. 2. Tangential section of the same, similarly enlarged.
Fig. 3. Tangential section of *Labechia serotina*, Nich., enlarged twelve times. Middle Devonian, Devonshire.
Fig. 4. Vertical section of the same, similarly enlarged.
Fig. 5. Vertical section of *Labechia canadensis*, Nich. & Mur., enlarged twelve times. Ordovician (Jewesche Zone), Saak, Esthonia.
Fig. 6. Part of an exfoliated specimen of *Labechia? Schmidtii*, Nich., enlarged about six times. Silurian (Upper Oesel Zone), Hoheneichen, Oesel.
Fig. 7. Tangential section of the same, enlarged twelve times.
Fig. 8. Vertical section of the same, similarly enlarged.

IV.—*The Origin of Metagenesis among the Hydromedusæ.* By W. K. Brooks *.

Most of the recent writers upon the origin of the sexual Medusæ which are set free from communities of sessile hydroids, and upon the relation between them and the hydroids, agree in the opinion that the sessile community is the primitive form, from which the Medusæ have been derived through division of labour, and the gradual specialization of the reproductive members of a polymorphic hydroid cormus.

In a monograph which has just been published in the 'Memoirs of the Boston Society of Natural History' ("The Life-history of the Hydro-Medusæ: a Discussion of the Origin of the Medusæ, and of the Significance of Metagenesis") I show that the life-history of the Narcomedusæ and Trachomedusæ is irreconcilable with this view. The accepted view regarding these groups of Medusæ is that they have been evolved from ancestors with a sessile hydra-stage and an alternation of generations, and that they have gradu-

* From the 'Johns Hopkins University Circulars,' No. 49, May 1886, pp. 86–88.

ally lost the hydra-stage, so that they now develop directly from the egg. I show that there is no reason for this opinion, but that we have in *Liriope* among the Trachomedusæ and in *Ægineta* and *Cunina octonaria* among the Narcomedusæ a true planula-stage and a true hydra-stage, although the hydra is simply a larva which develops into a medusa by direct growth and metamorphosis without alternation of generations. The life-history of these forms proves conclusively that the medusa-stage is older than the sessile hydroid cormus, which has arisen through the power to multiply asexually which is possessed by the hydroid larva of the medusa.

We have among the existing hydroids the series of stages in the origin of metagenesis which are represented in the following diagrams, in which the sign = denotes direct metamorphosis without multiplication, the sign × denotes asexual multiplication, and the sign < denotes sexual multiplication.

In *Æginopsis,* as Metschnikoff shows, the egg gives rise to a ciliated swimming planula, which acquires a mouth and tentacles, and thus becomes directly and gradually converted into a floating hydra or *actinula,* which is at first ciliated like the planula. The tentacular zone of the floating hydra now grows out into a flange or umbrella, which carries the tentacles with it; sense-organs and a veil are soon acquired, and the hydra becomes a medusa.

The whole process is perfectly simple and direct; there is nothing like an alternation of generations, and the single egg becomes a single medusa with an actinula-stage, a floating, hydra-like, larval stage, and a swimming medusa-stage. The life-history is as simple and uninterrupted as that of any other animal which undergoes a metamorphosis, and it may be represented by the following simple diagram :—

I. ÆGINOPSIS : *Egg = Planula = Actinula = Medusa < Eggs.*

As the floating hydra-stage of *Tubularia* is well known under the familiar name *Actinula,* and as it seems desirable to use a special term for the free hydra-stage of Medusæ as distinguished from a sessile hydroid, I shall employ this word for this purpose, designating by it a free or floating hydra, which may or may not be ciliated.

I have shown that we have in *Liriope* and its allies a life-history which is very similar to that of *Æginopsis,* with numerous secondary modifications, most of which are due to the fact that the gelatinous substance of the umbrella begins to be secreted between the endoderm and the ectoderm at a very early stage in the life of the embryo. The acceleration

of the formation of the umbrella is exactly parallelled by innumerable similar phenomena in the lives of nearly all of the higher Metazoa, and it therefore presents no difficulties; and if we imagine the gelatinous substance absent, the mouthless, untentaculated, ciliated *Liriope*-larva is obviously a planula with an outer layer of ectoderm and a central capsule of endoderm. It has a spacious digestive cavity; the two layers are separated by a gelatinous substance; and in our species the cilia are restricted to a small part of the outer surface; but, in spite of these secondary modifications, it is clearly a planula. It soon acquires a mouth and four solid tentacles, and becomes converted into the floating hydra or actinula, with ectoderm, endoderm, stomach, mouth, lasso-cells, and four tentacles, but with neither subumbrella, sense-organs, nor veil. This larva becomes converted into an adult medusa by the growth of the tentacular zone into an umbrella, and by the acquisition of sense-organs, precisely like the *Æginopsis*-larva, and as each egg gives rise to only one adult, the life-history is simple and direct, with a planula-stage, a hydra-stage, and a final medusa-stage, and it may therefore be represented by the same diagram which was used for *Æginopsis*:—

II. Liriope: *Egg = Planula = Actinula = Medusa < Eggs.*

In our common American Narcomedusa, *Cunina octonaria*, the fact that the larva is a true hydra was long ago pointed out by McCrady. The planula-stage of this species has never been observed; but the resemblance between the ciliated, bitentaculated hydra and Metschnikoff's account of the *Æginopsis*-larva at the same stage is so close, that we have every reason for believing that in this species also the hydra-stage is preceded by a planula-stage without a mouth or tentacles. The hydra soon acquires two more tentacles, and is then fundamentally like the four-tentacled hydra of *Liriope*. The number of tentacles soon increases to eight, and the hydra becomes converted into a medusa by the outgrowth of the tentacular zone and the acquisition of sense-organs. So far the life-history of our *Cunina* is as simple as that of *Æginopsis* or *Liriope*; but it is complicated by the occurrence of asexual multiplication in the larva and also by parasitism. The actinula, or floating ciliated hydra, after gaining access to the subumbrella of a *Turritopsis*, gives rise to buds from the aboral end of its body, behind the circlet of tentacles; each of these buds is a hydra like the parent, and, like it, becomes directly converted into a medusa. As these secondary hydras originate as buds, they are at first sessile; but

they become detached while in the hydra stage, or at least before they are completely converted into true medusæ. The time of detachment is not constant, and although the larvæ are at first sessile, and therefore not actinulas, they serve to show that the boundary-line between a floating actinula and a sessile hydra is an extremely faint one.

Owing to the occurrence of asexual multiplication, each *Cunina* egg may give rise to an indefinite number of adult medusæ; but as each larva becomes directly converted into a medusa by a process of growth, there is no alternation, and the life-history may be represented by the following diagram:—

$$\begin{array}{rl} & \textit{Hydra} = \textit{Medusa} < \textit{Eggs.} \\ & \times \\ \text{III. CUNINA OCTONARIA: } \textit{Egg} = \textit{Planula} = & \textit{Actinula} = \textit{Medusa} < \textit{Eggs.} \\ & \times \\ & \textit{Hydra} = \textit{Medusa} < \textit{Eggs.} \end{array}$$

Here we have asexual multiplication without alternation; but in the *Cuninas* which Uljanin and Metschnikoff studied there is a true alternation which is obviously of secondary origin and undoubtedly due to a very slight modification of such a life-history as the one shown in diagram III. The planula itself is very peculiar and is furnished with an anomalous pseudopodial apparatus for clinging to and fastening upon the gastric process of the Geryonid within which it becomes a parasite; and the actinula or primary hydra into which it becomes converted never completes its development into a perfect free medusa. It remains as a brood-stock, from which other larvæ are budded, and these are set free and become converted into medusæ, so that the life-history is represented by the following diagram, in which for the first time we find a true alternation:—

$$\begin{array}{r} \text{IV. CUNINA (CUNOCANTHA) PARASITICA:} \\ \textit{Egg} = \textit{Planula} = \textit{Actinula} \times \end{array} \left\{ \begin{array}{l} \textit{Hydra} = \textit{Medusa} < \textit{Eggs.} \\ \textit{Hydra} = \textit{Medusa} < \textit{Eggs} \\ \textit{Hydra} = \textit{Medusa} < \textit{Eggs.} \end{array} \right.$$

A comparison of Metschnikoff's account of the development of *Cunina* (*Cunocantha*) *parasitica* and that which I have given of *Cunina octonaria* will bring out an interesting and significant difference between them which I have not yet pointed out. In the American *Cunina* the hydra-stage is well marked in the larvæ which are produced by budding as well as in the one which hatches from the egg. In Metschnikoff's species, however, the characteristics of the adult medusa begin to make their appearance in the secondary buds

almost as soon as the buds themselves appear, and it would be difficult to recognize a hydra-stage in the life of this species if we were not acquainted with the simpler life-history of the American *Cunina*. In Metschnikoff's species the primary hydra is also greatly modified as an adaptation for its parasitic life, but in other respects its life-history is very similar to that of the ordinary hydroids; and if the acquisition of the medusa-characteristics by the secondary buds were a little more accelerated, so that their hydra-characteristics were entirely, instead of almost, crowded out, we should have a life-history like this:—

$$\text{V. } \mathit{Egg} = \mathit{Planula} = \mathit{Actinula} \times \begin{cases} \mathit{Medusa} < \mathit{Eggs}. \\ \mathit{Medusa} < \mathit{Eggs}. \\ \mathit{Medusa} < \mathit{Eggs}. \end{cases}$$

I know of no hydra which presents this life-history without modification; but there are many Campanularians and Tubularians in which the only modification is the acquisition by the actinula or primary hydra of the power to produce, in addition to the buds which become medusæ, other buds which remain in the hydra-condition, and share with their parent, the primary hydra, the power to produce both kinds of buds. Thus in *Perigonymus* (*Stomatoca*) the egg gives rise to a planula, which becomes the first hydra, and this produces other hydras like itself, and builds up a hydroid cormus; and ultimately all these hydras give rise to buds which become directly converted into medusæ, the hydra-like stage being completely suppressed; and we have a life-history like this:—

$$\begin{array}{rcl} & \mathit{Hydra} \times & \left\{\begin{array}{l} \mathit{Medusa} < \mathit{Eggs}. \\ \mathit{Medusa} < \mathit{Eggs}. \end{array}\right. \\ & \times & \\ & \mathit{Hydra} \times & \left\{\begin{array}{l} \mathit{Medusa} < \mathit{Eggs}. \\ \mathit{Medusa} < \mathit{Eggs}. \end{array}\right. \\ & \times & \\ \text{VI. } \mathit{Egg} = \mathit{Planula} = \mathit{Actinula\ or\ Primary} & \mathit{Hydra} \times & \left\{\begin{array}{l} \mathit{Medusa} < \mathit{Eggs}. \\ \\ \mathit{Medusa} < \mathit{Eggs}. \end{array}\right. \\ & \times & \\ & \mathit{Hydra} \times & \left\{\begin{array}{l} \mathit{Medusa} < \mathit{Eggs}. \\ \mathit{Medusa} < \mathit{Eggs}. \end{array}\right. \\ & \times & \\ & \mathit{Hydra} \times & \left\{\begin{array}{l} \mathit{Medusa} < \mathit{Eggs}. \\ \mathit{Medusa} < \mathit{Eggs}. \end{array}\right. \end{array}$$

In *Turritopsis* we have essentially the same life-history, except that there is a secondary alternation between the primary hydra and the others. The planula does not become a hydra, but a mouthless untentaculated root, which is undoubtedly a degraded actinula or primary hydra. It does not give rise to medusa-buds, but remains as a brood-stock or embryonic hydra, from which fully-developed hydras are formed by budding; and all of these produce medusa-buds, so the life-history is as follows:—

$$\text{Turritopsis}: \ \textit{Fgg} = \textit{Planula} = \textit{Root} \times \left\{ \begin{array}{l} \textit{Hydra} \ \times \left\{ \begin{array}{l} \textit{Medusa} < \textit{Eggs.} \\ \textit{Medusa} < \textit{Eggs.} \end{array} \right. \\ \textit{Hydra} \ \times \left\{ \begin{array}{l} \textit{Medusa} < \textit{Eggs.} \\ \textit{Medusa} < \textit{Eggs.} \end{array} \right. \\ \textit{Hydra} \ \times \left\{ \begin{array}{l} \textit{Medusa} < \textit{Eggs.} \\ \textit{Medusa} < \textit{Eggs.} \end{array} \right. \end{array} \right.$$

In the ordinary Campanularians, with free medusæ, we have a new element of complexity, owing to the appearance of polymorphism. The ordinary hydras no longer give rise to medusa-buds, and these are produced only on the reproductive hydras or blastostyles. In *Eutima*, which I shall take as an example of this group, we have another complication which is very significant.

As in *Turritopsis*, there is a secondary alternation of generations, for, as I have shown above, the planula no longer becomes converted into a hydra, but forms a root from which the primary hydra is budded like those which appear later.

As I have shown, this secondary alternation occurs in many hydroids, such as *Hydractinia*, *Eutima*, *Turritopsis*, *Obelia* (Merejkowsky), and others, and it was correctly described by Wright in *Hydractinia* in 1856; but, so far as I am aware, no one has pointed out that it is a true alternation, exactly like the alternation between the hydra and the medusa, and that it is certainly a secondary acquisition, as we may see from the fact that in *Tubularia*, *Eudendrium*, and other hydroids the planula becomes directly converted into a hydra. So far as this point is concerned, the life-history of *Eutima* or *Hydractinia* and that of *Tubularia* or *Eudendrium* present the following contrast :—

$$\begin{array}{r} \textit{Hydra} \\ \times \\ \text{Tubularia}: \ \textit{Egg} = \textit{Planula} = \textit{Actinula} = \textit{Hydra} \\ \times \\ \textit{Hydra} \end{array}$$

with no alternation, while in the other forms we have

$$\text{Eutima}: \ \textit{Egg} = \textit{Planula} = \textit{Root} \times \left\{ \begin{array}{l} \textit{Hydra} \\ \textit{Hydra} \\ \textit{Hydra} \end{array} \right.$$

with an alternation.

The complete life-history of *Eutima*, with its double alternation between the root and the hydranths, between the hydranths and the medusæ and its polymorphism, and division of the hydranths into nutritive persons and blastostyles, may be represented as follows :—

VII. Eutima:
Egg=Planula=Root ×
Nutritive Hydra × { *Blastostyle* × { *Medusa<Eggs.* / *Medusa<Eggs.* / *Medusa<Eggs.* } / *Nutritive Hydra* }
Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa<Eggs.* / *Medusa<Eggs.* / *Medusa<Eggs.* } }

In *Podocoryne* (*Dysmorphosa*) we have an extremely complex life-history, which, however, is readily derivable from one like that of *Eutima* as just given. There is a secondary alternation between the root and the hydranths, as in *Eutima*, and the polymorphism between the hydranths is more specialized, as we find not only nutritive polyps and blastostyles, but defensive polyps as well; and as each of the medusæ, in addition to its sexual function, also possesses the power to produce other medusæ by budding, the number of sexual animals which may be derived from a single egg is unlimited.

The following diagram represents the life-history of this species, except that the first generation of medusæ, like the second, gives rise to reproductive elements:—

Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } / *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } } / *Defensive Hydra* }

×

VIII. Podocoryne:
Egg=Planula=Root ×
Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } / *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } } / *Defensive Hydra* }

×

Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } / *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } } / *Defensive Hydra* }

Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } / *Medusa* × { *Medusa<Eggs* / *Medusa<Eggs* } } / *Defensive Hydra* }

×

Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa* × { *Medusa<Eggs.* / *Medusa<Eggs.* } / *Medusa* × { *Medusa<Eggs.* / *Medusa<Eggs.* } } / *Defensive Hydra* }

×

Nutritive Hydra × { *Nutritive Hydra* / *Blastostyle* × { *Medusa* × { *Medusa<Eggs.* / *Medusa<Eggs.* } / *Medusa* × { *Medusa<Eggs.* / *Medusa<Eggs.* } } / *Defensive Hydra* }

It is very probable that future research will show that even this complex diagram is too simple for some of the Hydromedusæ, and that there is, in some cases, a secondary alternation between the first generation of free medusæ and those which are produced by budding from this generation. The life-history of these proliferous medusæ has not been studied, as they are seldom found near laboratories and appliances for research; but there is reason to suspect that in some of them only the medusæ which are budded from the bodies of the medusæ of the first generation become sexually mature; and if future research should prove this, we should have still another alternation between the asexual proliferous medusæ and these sexual descendants.

In *Hydractinia*, the cormi of which are so similar to those of *Podocoryne* that a drawing of one will correctly represent the other, the life-history begins to simplify itself by the degradation of the sexual medusæ into sessile buds or reproductive organs, which, however, still retain traces of their former independent locomotor existence, traces which have almost totally disappeared in *Eudendrium* and in many of the Campanularians.

The life-history of *Hydractinia* may be represented as follows:—

$$\begin{array}{c}\text{IX. HYDRACTINIA :}\\ \textit{Egg}=\textit{Planula}=\textit{Root}\times\end{array}\begin{cases}\textit{Nutritive Hydra}\times\begin{cases}\textit{Nutritive Hydra}\\ \textit{Blastostyle}\\ \textit{Defensive Hydra}\end{cases}\times\begin{cases}\textit{Medusa Bud}<\textit{Eggs.}\\ \textit{Medusa Bud}<\textit{Eggs.}\end{cases}\\ \textit{Nutritive Hydra}\times\begin{cases}\textit{Nutritive Hydra}\\ \textit{Blastostyle}\\ \textit{Defensive Hydra}\end{cases}\times\begin{cases}\textit{Medusa Bud}<\textit{Eggs.}\\ \textit{Medusa Bud}<\textit{Eggs.}\end{cases}\\ \textit{Nutritive Hydra}\times\begin{cases}\textit{Nutritive Hydra}\\ \textit{Blastostyle}\\ \textit{Defensive Hydra}\end{cases}\times\begin{cases}\textit{Medusa Bud}<\textit{Eggs.}\\ \textit{Medusa Bud}<\textit{Eggs.}\end{cases}\end{cases}$$

Now what is the significance of this remarkable series of life-histories? Most of the facts have long been known; but the most conflicting interpretations of them have been advanced, and the student who seeks in the various monographs upon the subject an exposition of the relation between the direct development of a single adult from each egg, which is characteristic of most animals, and the circuitous history which is so remarkably exhibited by the medusæ, will find a speculative literature which is almost unlimited, but a total lack of agreement as to the true solution of this, the most interesting of all the problems involved in the life of these most interesting animals.

The view which I believe to be the true one is that the remote ancestor of the hydromedusæ was a solitary swimming hydra or actinula, with no medusa-stage, but probably with the power to multiply by budding. I believe that this pelagic animal gradually became more and more highly organized and more perfectly adapted for a swimming life, until it finally became converted into a medusa with swimming-bell and sense-organs, developing directly from the egg without alternation, but exhibiting during its growth the stages through which it had passed during its evolution. After this stage of development had been reached, I believe that the larva derived some advantage from attachment to other bodies, either as a parasite within other medusæ or as what may perhaps be called a semi-parasite upon other floating bodies, such as the fronds of algæ; and that it multiplied asexually in this sessile condition, giving rise to other larvæ like itself, all of which became medusæ.

I believe that the sessile or attached mode of life of the larvæ proved so advantageous to the species that it was perpetuated by natural selection, and that the primary larva then gradually lost its tendency to become a medusa, but remained a sessile larva, giving birth by budding to other larvæ which became sexual medusæ; that the medusa-characteristics of these secondary larvæ were accelerated, and that the primary larva gradually acquired at the same time the power to produce other larvæ, which remained permanently, like itself, in the hydra stage; that in this way the sessile hydra-communities with medusa-buds and free sexual medusæ were evolved; and that finally these communities became polymorphic, and that the sessile habit proved so advantageous that the free medusæ became degraded into medusa-buds or sexual buds on the bodies of the sessile hydras.

V.—*Endogenous as distinct from Exogenous Division in the Amœban Rhizopods.* By Surgeon-Major Wallich, M.D.

I propose to show in this communication that whereas endogenous division in the naked Amœban Rhizopods is the prime factor in normal reproduction, exogenous division, in the majority of instances in which it is seen to take place during microscopic observation, is merely a mechanical disruption of the body-substance into two or more separate masses, produced accidentally by forces operating from

without. In the former case it is a normal physiological process originating in an inherited idiosyncrasy of the organism, independently of any externally applied force; in the latter it is almost always a mere mechanical disruption of the animal's body-substance, brought about entirely by forces which are in nowise inherent in the organism. In short, endogenous division must be regarded as a normal function of the Amœban structure, indispensable for the perpetuation of its kind; exogenous division being in reality an abnormal lesion of the structure calculated to interfere with the natural functions and development of the individual, just as it does in cases of injury accidentally inflicted on more highly organized creatures.

My attention having been lately redirected to this subject by the receipt of an important paper "On the Biology and Physiology of the Protozoa" * kindly sent me some months ago by Prof. Gruber, of the University of Freiburg (a translation of which, by Mr. W. S. Dallas, F.L.S., appeared in last month's issue of the 'Annals'), I am in hopes that the present observations may serve not only to confirm Dr. Gruber's views, but to furnish some new facts in relation to that portion of his paper which deals briefly but specially with "The Significance of the Nucleus in the Regeneration" of the *Amœbæ*; the main portion of the paper being devoted to an exposition of the physiology of the Stentors and other Infusoria proper.

But although I fully accept Dr. Gruber's conclusions concerning the paramount importance of the nucleus as a reproductive organ, and, as far back as 1865, showed my recognition of the fact by dividing the Rhizopods into three distinct orders based *entirely* on the absence or presence of the nucleus and contractile vesicle, I regret that I cannot accept the inference that division as noticeable in *Amœba* when produced by artificial means, such as pressure or the dissecting-needle and ophthalmic scalpel, and when conducted under conditions so palpably unfavourable to the preservation of vitality in the detached masses of the Amœban body as imprisonment on an ordinary microscopical slide, can be regarded as affording a trustworthy parallel with what takes place when an accidentally-divided *Amœba* is living in the midst of its natural habitat. Indeed it appears to me to be extremely doubtful if exogenous division, in my sense of the term, takes place at all under strictly normal conditions. When it occurs whilst the organism is under observation on a slide, it is only

* 'Berichte der naturforschenden Gesellschaft zu Freiburg i. B.,' Band i. (1886) Heft 2.

when the creature is subjected to undue pressure, or its movements are impeded by foreign matter, through which it has difficulty in forcing a passage. Whereas under perfectly natural conditions the creature is in all probability able either to push aside the obstructing matter or select another route. When closely confined between the glass slide and cover it has no such easy alternatives. Therefore all that can be safely inferred from watching the behaviour of an artificially or accidentally-divided and enucleate portion of an *Amœba* is, that being endowed, in common with the rest of the body, with a diffused nervous faculty, this portion is, for some unknown reason, more detrimentally affected by the shock sustained by it than the remaining portion which possesses the nucleus.

Why the possession of the nucleus (which is never a permanently fixed organ in the *Amœbæ*) should carry with it a superior degree of vitality, it is as yet impossible to say with any certainty. But, as first shown in my papers on "*Amœba villosa* and other Indigenous Rhizopods," in the 'Annals' for May and June 1863 (pp. 366, 436, and 437), and also in subsequent numbers of the same journal, there evidently subsists an intimate relation between the nucleus and the unique persistent area of the Amœban surface constituting its posterior region, whether this region be covered with any of the varieties of villous appendage or consist merely of a specially differentiated outer layer of sarcode—the intimacy of this relation becoming almost certain, firstly, from the specially differentiated area never undergoing *Amœbasis* (as every other part of the sarcode body does) or taking part in the general pseudocyclosis; secondly, from the nucleus, after participation for a time in the general pseudocyclosis, almost always coming to rest in the vicinity of the area in question; and, thirdly, from the contractile vesicle, after participation temporarily in the pseudocyclosis, also coming to rest and generally discharging its contents close to the same region.

The extraordinary degree of vitality possessed by the posterior portion of *Amœba* is very signally manifest when lump after lump of the anterior portion is bitten off by some creature that preys on it, as, for instance, *Coleps hirtus*, or another *Amœba* with cannibal proclivities. Under these circumstances, if the nucleus and specially differentiated area remain intact, the original mass, although reduced to less than even half its normal bulk, will, in the course of an hour or so, move away as energetically as if no injury whatever had happened to it. Now this is precisely the condition of things existing when

artificial division is effected by the scalpel or other mechanical means.

As regards spontaneously occurring division—that is to say, division effected by the mere contractility of the sarcode and without participation on the part of the nucleus—nothing is as yet known so far as I am aware. At the same time, I will not undertake to say that spontaneous division, in the sense indicated, may not occasionally take place under natural conditions. But even should spontaneous separation take place fifty times, or fifty times fifty, the process would not result in "regeneration," this being impossible unless the nucleus participates to such an extent as to apportion some share of the fecundative granules of which it consists to each separated fragment.

Nor have we any positive information as to whether a detached enucleate fragment of *Amœba* retains the faculty of digesting any food-material it may seize with its pseudopodia. But if negative evidence of a very powerful and constant kind is of any value, it is, I think, justifiable to assume that no detached enucleate portion of the Amœban body-substance can reproduce its kind in a perfect form, or multiply otherwise than by a repetition of purely unreproductive division.

Unfortunately our knowledge of the physiological functions belonging to these organisms must remain incomplete so long as the extraordinary difficulties inseparable from any strictly continuous examination of individual specimens from the beginning to the close of their entire life-cycle, under conditions not liable to interfere to any material extent with their free and healthy development, remain to be overcome. These difficulties, overcome as they nevertheless have been in the case of much more minute organisms than the Rhizopods, namely in the Monads, through the indefatigable perseverance and scientific skill of Messrs. Dallinger and Drysdale, are augmented rather than diminished in the case of the *Amœbæ*, owing to the more protracted periods occupied by these organisms in passing through the various phases of their existence. For the present we must therefore rest content with collecting, piecemeal, all facts that bear upon the subject, and trust to the zeal of such competent observers as Dr. Gruber to work them out to their legitimate conclusions.

It now only remains for me to invite attention to a novel means of rendering the nucleus visible in the naked Rhizopods, and probably in the Protozoa generally, when the detection of this organ is rendered difficult, or even impossible, by being surrounded by more or less opaque particles of different kinds; the necessity for some more efficacious way of detect-

ing its presence than has heretofore been employed becoming obvious when, as shown by me in the case of *Gromia* (and as I believe will be found to be the case in every one of the naked Rhizopods which have hitherto been relegated to the lowest order of that group of organisms chiefly on account of being supposed to be deficient in this organ), it is almost certain that the error has arisen from the extreme difficulty, often encountered, of rendering the nucleus visible. The superiority of the method I am about to describe consists in its being simple, easy of application, and sure.

During some experimental trials I was making on the effect of a galvanic current passed through the water on slides containing living *Amœbæ* and other organisms, which generally resulted in their being instantaneously killed without rendering their internal organization more distinct than it was before, it occurred to one of my sons to try the effect of ordinary frictional electricity. The result proved most gratifying; for although, as in previous cases, the *Amœbæ* were instantly killed, their entire bodies were at the same time burst up, so to speak, into a homogeneous-looking mass of granular particles, the nucleus, however, in every instance forming a conspicuous object in the midst of these. So marked was this result that in some perfectly clean gatherings of *Raphidiophrys elegans*, so numerous that each field of the microscope was simply crowded with them, but in none of which a nucleus could be previously discerned, the instant the discharging knobs communicating with a single small Leyden jar were applied on opposite sides of the glass cover, and of course in contact with the water between the cover and slide, the effect I have described was produced in every one of them. The only precaution that has to be attended to is not to employ too powerful a discharge.

VI.—*Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia, continued.* By H. J. Carter, F.R.S. &c.

[Continued from vol. xvii. p. 516.]

Order VIII. CALCAREA (*continued*).

Observation.

Following Polèjaeff's arrangement the Sycones will be inserted here, that is before the Leucones, as the radial chambers in the simplest and most typical forms, ex. gr. *Grantia ciliata*, Bk. (*Sycandra ciliata*, H.), appear to be closely allied

in structure to the tubulation of the Ascones, where the latter begin to present "parenchyma," inasmuch as the radial tube of *Grantia* is solely composed of a spicular skeleton consisting of a single layer of small radiates, whose interstices are tympanized by sarcode plentifully traversed by pores, and whose intervals are filled with parenchyma supporting the young ova &c., with Häckel's "intercanal system." Indeed the amount of parenchyma in *Clathrina ventricosa* far exceeds that to be found in any of the Sycones, as will be seen hereafter, and thus, as before stated, in this respect it more nearly approaches Häckel's Leucones (ex. gr. *Leucaltis floridana*) than any of the Sycones.

9. *Sycandra Ramsayi*, von Lendenfeld.

Sycandra Ramsayi, von Lendenfeld, Proc. Linn. Soc. New South Wales, vol. ix. pt. 4, p. 1097.

This sponge, which has been well described and illustrated by Dr. R. von Lendenfeld (*op. et loc. cit.*), is easily recognized by its comparatively large size and the closeness of the hairy surface, which has been so much worn away in my specimens that it now looks like a "shoe-brush" or the coat of a "clipt" horse. The tufts of spicules with which it is covered are so close together that the surface instead of being granulated by them, as in *Grantia ciliata*, is continuously uniform, so that the whole, including the long stout peristome, has when dry a glistening silky appearance; still, by pushing aside the tufts, the usual pore-areas may be seen between them which also respectively cover their radial chambers on the outside; but this is not shown in Dr. Lendenfeld's illustration (*op. cit.* pl. lxvi. fig. 37). Internally the holes of the cloaca, although honeycomb-like in appearance, are almost circular, and so generally in apposition that it is only here and there that any "intercanal" space for the parenchyma can be seen between them; their margins are sparsely echinated with the fourth ray of the quadriradiate, which is comparatively short, and the radial chambers extending outwards from them are long and skeletally "articulated" with characteristically small, thin, triradiate spicules of much the same size, but for the most part sagittal in form. The minute acerate spicules from the base of the tufts represented by Dr. Lendenfeld form part of the medium of attachment between the tufts and the elongated shafts of the triradiates at the outer end of the radial tube; these are sinuous and larger

at one end than the other, which is lance-pointed *, altogether about 13 by $\frac{2}{3}$-6000th in. in their greatest dimensions—in short they form Häckel's "Stäbchenmortel," and are what I have proposed to call "mortar-spicules." Of the terminations of the long acerates of the tufts I know nothing, as they are all broken off except a few of the shorter ones, which are *simply* pointed. The most complete specimen of this species in Mr. Wilson's collection is much compressed, about 1 in. long and $\frac{3}{4}$ in. broad; with a large peristome of glistening, silky, fine acerates now arranged conically, altogether about 3-24ths in. in diameter at the base and 5-24ths in. long, which, of course, is the diameter of the mouth.

10. *Grantia subhispida.*

Individualized. Sacciform, elongate, somewhat pyriform, diminishing in size abruptly towards the free and gradually towards the fixed end. Surface presenting a checkered appearance owing to the presence of lines crossing each other spirally and obliquely upwards, at the intersections of which a tuft of long projecting spicules is situated, and in the intervals a cribrate, stelliform area, arched outwards. Pores in the dermal sarcode stretched over these cribriform areas, in short the holes of the cribriform structure itself. Vent large, single, terminal, subcircular or twisted, like a slit nostril; surrounded by a palisading of long linear spicules, leading into a cloaca which corresponds in shape to that of the specimen, and whose surface is scattered over with holes separated by a thick spicular framework; holes not superficially sphinctered, but presenting two or more sphinctered openings *within* the margin belonging to the internal structure. Wall composed of radiating cylindrical chambers in juxtaposition, whose skeletal structure is "articulate," tympanized with sarcode, pierced by the usual pores of intercommunication, and more or less accompanied by parenchymatous or intercameral intervals; outer ends of the chambers respectively covered by the spicular tufts and cribriform areas, and their inner ends opening in pairs, within the holes of the cloaca respectively, as before stated. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. one long, fine, linear, straight and simple, pointed at each end, arranged parallelly to each other around the mouth; the other much stouter, curved, simple or lanceolate at one end, chiefly

* When the word "lance" is used with reference to the form of the end of a spicule, it must be understood to mean lozenge-shaped or conical as the case may be.

arranged around the external ends of the radial chambers to which they belong. 2, triradiates, varying in size and shape according to their position, that is from an equiangled to a sagittal form in which the arms are much expanded. 3, quadriradiates, whose fourth arm is short, curved towards the mouth, and projects into the cavity of the cloaca. No. 1 in its thin form is confined to the peristome, and in its stouter one to the tufts on the surface of the body, mingling also with the proximal ends of the peristome-spicules; no. 2 chiefly to the spicular skeleton of the radial chambers, which is thus "articulate;" and no. 3 chiefly to the cloaca, where its fourth arm thickly echinates the surface and circular holes of this cavity. Size of largest specimen, of which there are two, $1\frac{1}{4}$ in. long by 4-12ths in. in greatest diameter, which, the specimen being pyriform, is towards the free end; vent or mouth about $\frac{1}{6}$ in. in its greatest diameter.

Obs. This species, although closely allied to *Grantia ciliata*, differs from it in several particulars, viz. first in the pore-areas being much more circularly defined, arched outwards, and presenting a stelliform appearance; secondly, in the radial chambers being of the same size throughout, while in *Grantia ciliata* they widen outwards; and thirdly, in two or more openings of these chambers opening *inside* the holes of the cloaca respectively, while in *Grantia ciliata* each chamber has its appropriated opening in the cloaca, and each is sphinctered by a sarcodic diaphragm. The smaller specimen is charged with ova about 1-400th in. in diameter when dry, which possess the germinal vesicle and *now* are evidently *on the surface* of the radial chambers as much as in the parenchyma, where they are also present.

With reference to the position of the ova, they *must* be developed *ab initio* from the surface of the chamber or tube in *some* instances, as in the *Clathrinæ*, ex. gr. *C. osculum* &c., where the internal surface of the tubular thread of which it is composed is plentifully charged with them; since here there *can* be no "parenchyma," for there is no place for it.

11. *Grantia compressa*, auct.

The specimens of this species have grown on a small feathery *Fucus* in much the same condition as they grow here (Budleigh-Salterton, S. Devon).

12. *Grantia compressa*, var. *fistulata*.

The only difference between this and the usual compressed form of *G. compressa* is that it is tubular; it grows in a bunch contracted to the point of attachment, in which the individuals

are about 1 in. long by 1-16th in. in diameter, singly or bifurcated.

13. *Sycothamnus alcyoncellum*, H.

Sycothamnus alcyoncellum, H., Kalkschwämme, Atlas, Taf. lviii. fig. 5.

Easily recognized by its hollow, cylindrically-branched, coral-like form, checkered on the surface by spirally-intercrossing lines extending round the cylinder, with holes at the points of intersection. There is nearly as much as would fill a half-pint cup of this, all of which is in a fragmentary condition, wherein the naked and peristomed varieties (*S. arboreum*, H., fig. 7) appear to be mixed. In some of the "mortar-spicules" which Häckel describes in his text-book but does not represent in the 'Atlas,' the lanciform ends are serrated, like those of his *Leucandra saccharata* (Taf. xxxviii. fig. 13).

14. *Teichonella labyrinthica*, Carter.

Teichonella labyrinthica, Carter, 'Annals,' 1878, vol. ii., p. 37, pl. ii. figs. 6–10.

There are several specimens of this species, respectively complete and fragmentary, which enable me to modify to a certain extent what I stated formerly respecting it, inasmuch as the less involuted specimens show that it is goblet-shaped in general form and *not* simply "vallate," like *T. prolifera* (*op. et loc. cit.*); also that a *quadri*radiate forms part of its spiculation; hence these additional facts render it necessary that it should be relegated to the vicinity of *Grantia compressa*, where its generic name might be changed from "*Teichonella*" to "*Grantia*." It was the absence of the lower part and the imperfect state of the specimen generally that led me in the first instance to call it "vallate." As the structure of the stem has not already been noticed, it may be here stated that it consists of a solid, cylindrical, somewhat compressed mass of spicules, chiefly fine triradiates with very long shafts, and echinated with large, long, curved, fusiform acerates on the surface, which are partly free and partly imbedded in the general fabric. The largest specimen is $2\frac{1}{4}$ in. high, not including the stem, and 3 in. across the brim of the head when involuted; while the maximum thickness of the wall, which is towards the base, is 3-24ths in., diminishing gradually towards the border. The stem, which is somewhat contracted near the middle, is an inch long and about $\frac{3}{8}$ in. thick, expanding upwards into the wall of the head and downwards upon the object on which it has grown. One cannot help seeing in the compressed form of the involuted folds of the

head, which altogether is only $1\frac{1}{2}$ inch in its shortest diameter, while its longest, as above stated, is 3 inches, another character of *Grantia compressa* and its varieties.

The crater- or basin-like form, together with the arrangement of the excretory canal-system, causes this sponge to be very analogous in these respects to *Carteriospongia*, Hyatt, among the Keratosa, wherein the openings of the latter on each side of the wall being opposite each other, causes the specimen to present a cribriform appearance when placed between the observer and the light.

Observation.

We have now to leave that portion of Mr. Wilson's collection in which the typical form of the "radial chamber," viz. that in *Grantia ciliata*, which consists of an unbroken cylinder extending directly across the wall from the cortex to the cloaca, is replaced by a *sub*radial structure, in which the typical radial parallelism is more or less lost by the addition of large holes of intercommunication, more or less equal in diameter to the chambers themselves, which thus introduces a branching structure that is better seen in the vertical or horizontal section of the specimen than in the tangential one of the wall, in which the ends of the chambers appear to be almost as regular and as much in juxtaposition as they would be in *Grantia ciliata*. Hence the calcareous sponges presenting this "subradial" structure will be generically termed "*Hypograntia*" under the following diagnosis:—

HYPOGRANTIA.

Calcareous sponges in which the typical or radial structure of *Grantia ciliata* is more or less diverted from its parallelism by the addition of large holes of intercommunication between the chambers.

15. *Hypograntia infrequens* (incertæ sedis).

Individualized. Pyriform, sac-shaped, bent upon itself, peristomed. Colour whitish yellow outside, ferruginous within. Surface even, uniformly composed of large triradiates, fixed in their position by sarcode charged with minute mortar-spicules. Pores in the structure last mentioned. Vent single, terminal, circular, surrounded by the peristome, leading into a narrow cylindrical cloaca, corresponding in shape with that of the specimen; holes in the cloaca small, tolerably regular both in size and approximation, each provided with a sarcodic sphincter, like those of *Grantia ciliata*;

surface and holes of the cloaca thickly echinated with the fourth arm of quadriradiates curved towards the mouth. Structure of the wall consisting of radial chambers, most evident on the cloacal side, where they are defined by the long shafts of triradiates, whose heads are against the cloaca and whose shafts, directed perpendicularly outwards, abut upon the cortex, which consists of several layers of tolerably large triradiates, and is thus very thick; chambers uniformly pierced by pores alone until arriving at the cortex, where their continuity is broken up by the presence of large holes of intercommunication, which are continued to the pore-areas of the surface through a similar structure in the midst of the cortex. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. that common to the peristome in general and that of the surface, the latter minute and sinuous, with one end enlarged and lanceolate, in short the "mortar-spicule," about 28 by 1-6000th in.; 2, triradiates, also of two forms, both large, viz. those which compose the cortex, which are more or less regular, and those whose long shafts define the radial portion of the chambers, where they average 115 by 12-6000ths; 3, quadriradiates, with large, ensiform, curved fourth arms. No. 1 is confined to the peristome and surface; no. 2 to the cortex and interior of the wall, where the heads of the "long shafts" rest against the cloaca; no. 3 to the surface of the cloaca, where the fourth arm, which is stout, ensiform, and curved towards the mouth, *profusely* echinates the whole surface. Size of specimen about 6-12ths in. long by 2-12ths in. in its greatest transverse diameter.

Obs. The structure of this specimen so gave way that it became crushed under the knife while making the section; thus the wall and cloaca together became separated from the cortex. This in part might have been occasioned by decomposition, as indicated by the ferruginous colour of the inner portion; but it may be here stated that it is very likely to occur where the spicules are large and thick, on account of the little resistance then afforded by the sarcode; hence the advantage to be gained by imbedding the portion in paraffine, when the spicules are so firmly kept in their natural position that during the section they cannot swerve from it. There is enough present, however, in my section to show that there is still a portion of the typical radial chamber left in this species, and that it is "inarticulate;" while the thickness of the cortex, exceeding that of any other specimen in the collection, is very remarkable.

16. *Hypograntia hirsuta.*

Individualized; solitary or social. Sacciform, cylindrical, elongate, diminishing towards the free end, which is provided with a long peristome, also towards the fixed one, which is contracted to the point of attachment; covered with a hairy coat of long spicules, which together with the peristome when dry gives the whole a glistening silky appearance. Colour light grey. Surface overspread with tufts of acerate spicules in the midst of circular cribriform areas, which are more or less arched outwardly. Pores identical with the holes of the cribriform structure, which are comparatively large. Vent single, terminal, leading to a cloacal cavity corresponding in shape with the specimen, a little wider in the centre than the wall, which is comparatively thick; abundantly echinated with the fourth arm of the quadriradiate; holes of the cloaca large, irregular in size and distance apart, being more or less separated by the interspaces which the varying breadth of the superficies of the cavity presents; showing within the margin, which is profusely echinated, segments of one or more circular sphinctered openings which belong to the structure of the wall. Structure of the wall consisting of subradial chambers, *i. e.* only partly radial, arising from the radial form being more or less diverted from parallelism by large holes of intercommunication, besides the usual pores, especially in the outer and inner sides of the wall, where, in the former, they simulate the "subdermal cavities," and in the latter "subcloacal" ones also; opening in more or less plurality just inside the holes of the cloaca, as above stated; skeletally composed of small radiates, *i. e.* "articulated." Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. one thin, smooth, straight, long, silky about the mouth, and the other thicker, curved, and disposed in tufts about the body; 2, triradiates varying from regular to irregular or sagittal; 3, quadriradiates, the same, of which the fourth arm may average 20 by 2-6000ths. No. 1 confined to the peristome and tufts of the surface respectively, where the latter in combination forms a cone over the outer part of its chamber; no. 2, chiefly confined to the wall-structure and the surface respectively, where, in the latter, their rays support the cribriform sarcode, arching over the ends of the chambers which are not occupied by the "tufts;" and no. 3 to the cloaca, where the fourth arm thickly echinates the surface and margins of the holes of this cavity, as before noticed. Size of largest specimen (for there are several) about 9-12ths in. long, exclusive of the peristome, and 5-12ths

in. in greatest diameter, that is in the middle; cloacal cavity 3-24ths in. in diameter in the middle.

Obs. At first sight this looks very much like *Sycandra Ramsayi* from its hairiness; but when examined minutely it is found to present the structure above stated, which allies it almost as much to the Leucones as to the Sycones, hence the wall-structure is a mixture of both. The sarcode of the chambers is plentifully beset with ova, which appear to be in the last stage of segmentation.

17. *Hypograntia sacca*, von Lendenfeld, sp.

Grantessa sacca, v. Lend. *op. et loc. cit.* p. 1098, pl. lx. fig. 41, and pl. lxiii. fig. 42.

Individualized. Specimen large, pyriform, compressed to flatness, sacciform, somewhat bent upon itself, free and open at the small end, which is truncate and bears the remains of a peristome that has been broken off, so that, at first sight, it appears to be naked or without one; convex at the large end, where the point of attachment was by the most prominent part. Colour sponge-brown. Surface consisting of cribriform sarcode densely charged with small radiates, through which project a number of glistening cones consisting of long acerates; pores of the cribriform structure large, averaging about 1-207th in. in diameter, or just half the size of the holes in the cloaca; cones irregular in form, of different sizes, and at various distances apart, averaging about 1-415th in. in diameter at the base, and 1-207th in. from each other; but all broken off in the specimen, so that their length cannot be ascertained. Pores in the cribriform structure as just stated. Vent single, terminal, amounting in the compressed state of the specimen to a mere slit about 5-12ths in. long; furnished with a peristome, which has been broken off close to the lip; leading into a large cloacal cavity, which, on account of its compressed form, measures $1\frac{1}{2}$ in. in its greatest diameter; thickly scattered over with subcircular holes averaging 1-60th in. in diameter, or twice that of the "pores," as before stated, arranged for the most part in groups of three and four together, at variable distances apart, depending on the breadth of the intervening skeletal structure of the cavity; presenting *within* their borders one or more openings of the wall-structure; scantily echinated with short spines, that is the fourth arm of quadriradiates. Structure of the wall, which when compared with the diameter of the cloaca is very thin, not being more than 1-16th in., much the same as in *Grantia hirsuta*. Ends of the chambers of the wall-structure externally covered by the cribriform sarcode and the cones respectively. Spicules of three kinds, viz. acerate, triradiate,

and quadriradiate :—1, acerates, long, thin, cylindrical, glistening, silky in both peristome and cones, but, owing to the friction to which the specimen has been exposed, all, as before stated, broken off so short that their dimensions in length cannot be given, although, as usual, the length may be assumed to have been considerable. Dr. v. Lendenfeld estimates it (*l. c.*) at " 2–3 millim.," say about 5-48ths in. long. 2, triradiates, comparatively small, regular, and irregular or sagittal, and of variable size. 3, quadriradiates, which are very scanty. No. 1 confined to the peristome and cones, those of the latter spreading out tent-like over the outer ends of their chambers, and sinking deeply into the parenchyma; no. 2 to the wall and its limiting layers, viz. that of the surface and that of the cloaca, uniformly and comparatively small throughout; and no. 3 to the surface of the cloaca and margins of the pores on the surface where the scanty presence of the curved fourth arm indicates that of the quadriradiate itself. Size of specimen, whose sides are closely approximated, 2 in. long, by $1\frac{1}{2}$ in. in its widest diameter.

Obs. Although this species, in its dead state, is so much compressed, it is doubtful how far this would be the case when living undisturbed in its habitat. As it appears to be the same species as that described by Dr. R. v. Lendenfeld (*l. c.*), I have adopted his specific name for it. The surface in a dried specimen affords a beautiful object for the microscope, and altogether is so strikingly characterized that it only needs to be studied once to be unmistakably recognized thereafter.

The smaller specimen of this species, for there are two, appears to be in a better condition than the large one, inasmuch as it is stouter, though still somewhat compressed, and plentifully charged with ova, in apparently the "planogastrula" stage, situated chiefly on the *surface* of the chambers; but without any traces whatever of the small granuliferous spermatic-like cells seen where the ova are *not* in such an advanced stage of development. It is about an inch long and half an inch its longest diameter, containing a large crustacean in the cloaca quite ready, when living, to devour the embryos as they were discharged from the parent.

18. *Hypograntia extusarticulata.*

Agglomerated. Specimen consisting of a large bunch of long and short, more or less inflated, cylindrical sacs, with conotruncated ends; growing irregularly out of each other towards the base, all scantily peristomed. Colour whitish yellow on the surface, sponge-brown within. Surface even,

composed of uniformly cribrated sarcode densely charged with "mortar-spicules" and small triradiates, giving it a rough compact aspect. Pores, the holes of the cribriform structure, all tolerably uniform in size. Vents single, terminal, circular, at the end of each of the individuals; each provided with a short peristome, and each leading into its own cloaca, which corresponds in shape to the form of the individual, but is so much broader than the wall that the latter looks like a mere shell; holes numerous, small and great, but still tolerably uniform, permitting more or less of the openings of the wall-structure to be seen within them, according to their size; separated by the skeletal structure of the cloaca, which consists, like the surface of the body, of small triradiates, but with *no* "mortar-spicules." Wall thin, about 1-30th in. in diameter, consisting of subradial chambers like those of *Grantia hirsuta*, but more broken up in their parallelism by the large holes of intercommunication; covered by the pores of the surface externally, and opening, as before stated, into the holes of the cloaca internally; mixed in their skeletal structure, which consists of the "articulated" form *externally*, and the "inarticulated" one *internally*, but all comparatively small; thus the inner radiates of the "inarticulated" portion, which are the largest, have their sagittal heads fixed in the cloaca, while their shafts extend outwards horizontally to about the middle of the wall. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, long and short, the former fine, cylindrical, straight, and similarly pointed at each end, and the latter short, minute, more or less sinuous, fusiform, and lance-pointed at one end, about 15 by $\frac{2}{3}$-6000th in.; 2, triradiates, regular and irregular, comparatively small throughout, the larger, as before stated, on the inner side of the wall, where their shafts average 60-6000ths in. long; 3, quadriradiates, also regular and irregular in their triradiate portion, provided with a thick, curved, fourth arm. No. 1, in its two forms, is confined to the peristome and cribrate sarcode respectively, where the latter, which are the "mortar-spicules," mingle (as is the wont of the dermal acerate when present) in a larger form with the proximal ends of the peristomes; no. 2 is common to the wall and its limiting layers on each side, viz. the cloaca and the cortical layer on the surface of the body; no. 3 is chiefly confined to the surface of the cloaca, where its fourth arm, which projects into the interior of this cavity, is thick and curved, but not plentiful. Size of specimen, which, being an agglomeration, is of course very irregular, about 2 in. long by 1 in. thick; the largest individual of the bunch about $1\frac{1}{2}$ in. by 5-24ths in. in its greatest dimensions.

Obs. As in the two foregoing species so here, there are subdermal and subcloacal dilatations of the wall-structure into which the chambers of the latter open in more or less plurality.

19. *Hypograntia intusarticulata.*

Agglomerated. Specimen consisting of one large individual with several small ones growing out about the base, all without peristomes, the former cylindrical, truncate. Colour whitish yellow. Surface uniformly even, composed of cribriform sarcode densely charged with mortar-spicules and small radiates, so as to completely exclude the sarcode itself, which is thus faced by a minute hispid reticulation. Pores, that is the interstices of the reticulation, large, varying in size under 1-360th in. in diameter. Vent terminal, circular, without peristome, leading into a narrow cylindrical cavity, which, after a short distance, becomes wider and irregular in form as it extends into the smaller individuals; holes of the cloaca subcircular, very irregular both in size and distance apart, corresponding with the width of the spicular or skeletal framework of the cavity; presenting within their margins respectively from one to four openings in connexion with the chambers of the walls. Structure of the wall like that of *Grantia hirsuta* &c., viz. consisting of subradial chambers intercommunicating with each other by large holes as well as the usual pores; partly "articulate" and partly "inarticulate" in the composition of their skeleton, that is the small radiates occupying the *inner* third and the larger ones, through their long shafts, the *outer* two thirds of the wall. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, minute, sinuous, thicker towards one end than the other, viz. that which is lance-pointed, about 16 by $\frac{2}{3}$-6000th in., in short the "mortar-spicule;" 2, triradiates, regular and irregular or sagittal, of two sizes, viz. one small and the other large, with long shafts averaging 60 by 3-6000ths in., and arms about half this length; 3, quadriradiates scanty. No. 1 is confined to the surface, where, together with small radiates, it acts as the mortar-spicules of the dermal reticulation; no. 2, viz. the triradiates, in their smaller size, occupy the "articulated" portion of the parenchymal chambers, and the large ones the "inarticulated" part, where their heads are fixed in the cortex and their long shafts traverse the outer two thirds of the wall perpendicularly to the surface; no. 3, the quadriradiates, are chiefly confined to the surface of the cloaca, where the fourth arm, which is large, projects into the interior with its curve towards the mouth of this cavity. Size of specimen,

which is rather compressed, $\frac{3}{4}$ in. long by $\frac{1}{3}$ in. in its greatest transverse diameter.

20. *Hypograntia medioarticulata.*

Individualized. Pyriform, sack-like, peristomed, turned to one side at the fixed or small end, pear-like. Colour grey. Surface uniformly even, consisting of cribriform sarcode densely charged with mortar-spicules and small radiates, in short, exactly like that of *H. intusarticulata.* Pores, that is the holes of the cribriform structure, also about the same size, viz. varying under 1-360th in. in diameter. Vent single, circular, surrounded by a peristome; leading into a narrow cylindrical cavity, corresponding in shape with that of the outward form of the body, that is being widest above, where it is a little less in diameter than the maximum thickness of the wall; surface of the cloaca presenting large subcircular holes separated from each other by a thick and densely spiculated framework, sparsely echinated with thick curved spines (the fourth arm of the quadriradiate), more or less covered with a thin layer of sarcode which spreads itself in a cribriform state all over the surface of the cloaca, where it is best seen under the microscope in a dried condition. Structure of the wall in general like that of *H. intusarticulata*; also partly "articulate" and partly "inarticulate," but with the small radiates or articulate skeleton occupying the *middle* portion, the larger ones with their long shafts the *outer* half, and the smaller ones of this kind the *inner* quarter of the wall. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. the long, thin, cylindrical, glistening one of the peristome, and the other, the mortar-spicule, varying in size under 22 by 1-6000th in., more or less straight, *without* lanciform end; 2, triradiates, small and large, regular and irregular or sagittal, the large ones with straight shafts averaging 60 by 4-6000ths in. and arms about half this length; 3, quadriradiates, in which the fourth arm is comparatively stout and long. No. 1, in its longest form, is confined to the peristome, and in its shortest, viz. the mortar-spicule, to the dermal reticulation; no. 2, the triradiates, in their smallest size, occupy the "articulated," and the larger ones the "inarticulate" portions of the chambers, where their heads are fixed in the cortex and cloaca, and their long shafts traverse the outer and inner parts of the wall respectively, perpendicular to its sides; no. 3, the quadriradiates, chiefly in the surface of the cloaca, where the fourth arm projects into the interior and is more or less covered with the sarcode which, in a cribriform condition, lines the

cavity throughout, as before stated; also in a minute form echinating the interstices of the dermal reticulation, to which it thus imparts an additional hispid character. Size of specimen about 5-12ths in. long, and 2-12ths in. in its greatest diameter.

Obs. This specimen is remarkable for presenting the delicate sarcodic network over the surface of the cloaca which seems to occur occasionally (see Häckel's representation of *Leucetta pandora*, 'Atlas,' Taf. 22. fig. 3 *b*), sometimes, as in this case, occupying the whole of the cavity with its clathrous structure; also for the large size but sparse distribution of the fourth arm of the quadriradiate over the cloaca. Although like the foregoing species in many respects, it differs from it in general form and in the possession of a peristome.

In the last three species the "articulated" portion of the radial chamber is on the outside, the inside, and in the middle respectively, while the other portions respectively are supplied by the so-called "*in*articulated" skeletal structure.

Observation.

Still following the structure of the "wall" for arrangement, it becomes necessary to separate those species which present *no trace whatever* of "radial chambers" from those which do, although in a modified form, such as those last mentioned. Hence they will be generically named "*Heteropia*," in reference to the holes in the sarcodic structure of the wall, which here is traversed by the shafts of more or less large triradiates unaccompanied by smaller ones.

Heteropia.

Calcareous Sponges in which the wall is simply composed of sarcode supported on large sagittiform triradiates, whose heads are fixed in opposite sides of it respectively, and whose long shafts, extending perpendicularly across it, more or less overlap each other*.

21. *Heteropia polyperistomia.*

Individualized, social. Globular, elongate, rather bent upon itself, presenting six or more small, conical, glistening peristomes scattered over the body, which is otherwise echinated with thick, club-shaped, much curved, acerate spicules directed forwards. Colour grey-brown. Surface consisting of a rough, uneven, reticulate structure composed of the arms

* A similar structure is represented by Häckel in his illustrations of *Sycilla* (Atlas, Taf. 43. figs. 6, 9, and 10); but to say that it is composed of "Radial Tuben" appears to me to be a stretch of imagination.

of radiate spicules intercrossing each other, through which the curved sickle-shaped acerates project. Pores in the interstices of the dermal reticulation. Vents in plurality, scattered over the surface, at least six in number, each provided with a conical, glistening peristome, which contrasts strongly with the grey colour of the body, and all opening into a single cloaca, which is narrow, corresponding in shape with that of the specimen; in width about the same as the thickness of the wall; holes of the cloaca large and subcircular, separated from each other by variable distances in proportion to the width of the intervening spicular framework of the cloaca, presenting *within* their borders respectively one or more circular openings which appertain to the structure of the wall. Structure of the wall no longer presenting any trace of radial chambering beyond the parallelism of the long shafts of sagittal triradiates which successively following each other chiefly from within outwards traverse a simply clathrous cancellated sarcode, the shafts of the larger or inner triradiates being met by those of the smaller ones descending from the surface. Spicules of two kinds, viz. acerate and triradiate :—1, acerates of two forms, viz. one thin, straight, cylindrical, glistening, and silky, sharp pointed at each end; and the other thick, unequally fusiform, that is the outer portion being thicker than the inner one, and so curved in the outer part as to be almost sickle-shaped, about 150 by 2-6000ths in.; 2, triradiates, small and large, the latter averaging 100 by 6-6000ths in. in the shaft, and 40 by 4-6000ths in. in the arms respectively, which are spread out in a sagittal manner. No. 1, in its thin form, confined to the peristomes, and in its thick one to the surface generally, where it is curved towards the mouth, the larger or free end externally and the other attenuated and imbedded halfway through the wall; no. 2, the triradiates in their smaller forms chiefly confined to the spicular structure of the surface and that of the cloaca respectively, and the large ones to the wall, where the largest, whose measurements have been given, have their heads in the cloaca and their shafts directed outwards to meet the smaller ones which come from the surface. No quadriradiates were seen. Size of specimen 7-12ths in. long, by 5-12ths in. transversely. Two smaller ones growing from the base give the "social" character.

Obs. This specimen may be recognized by the number of small glistening peristomes scattered over the surface, the presence of the large sickle-shaped acerates of the surface, and the absence of the quadriradiate.

22. *Heteropia patulosculifera.*

Agglomerated. Specimen consisting of a large bunch of inflated sac-like individuals of different sizes irregularly growing out of each other, more or less conical, and opening respectively by, for the most part, large mouths indistinctly peristomed. Colour whitish yellow outside, sponge-brown within. Surface consisting of cribriform sarcode *without* mortar-spicules, knitting together triradiates, both regular and irregular, of tolerably uniform size, which is rather small; echinated, especially towards the mouth, with large, curved, fusiform acerates, sublanciform at the *free* end. Pores, the holes of the cribriform sarcode, small and large mixed, the latter about 1-280th in. in diameter. Vents single, terminal, more or less large as the free end of the individual is more or less conical, each provided with a short peristome, and all leading to a more or less general cavity which is rendered irregular in form by its branch-like extensions into the different individuals of the mass; far exceeding in size the thickness of the wall, which is thus reduced to a mere shell-like thinness; holes in the cloaca numerous, tolerably uniform in size and distance apart, each presenting one or more sphinctered apertures under the common level of the cloacal layer; these belong to the wall-structure, and thus simulate subcloacal cavities. Wall very thin, as before stated, compared with the bulk of the individual and the largely dilated cloacal cavity, about 1-40th in. in diameter, consisting of empty sinuous canals in juxtaposition, intercommunicating by pores and large holes respectively, the latter giving it a clathrous appearance; "holes" of intercommunication larger immediately under the pores of the dermis, simulating "subdermal cavities," and the same under the cloaca; skeletal structure chiefly composed of large triradiate spicules with long shafts, whose sagittal heads support the cortex on one side and the cloaca on the other, while their shafts more or less overlap each other horizontally in the intervening space. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. one thin, long, straight, cylindrical, similarly pointed at each end, and the other thick, curved, fusiform, and lanceolate at the free end, measuring about 140 by 10-6000ths in.; 2, triradiates of different sizes, large and small, regular and irregular, the largest sagittal much exceeding the rest in dimensions, being about 90 by 6-6000ths in. in the shaft, with arms respectively about half this length; 3, quadriradiates, similar in size in their triradiate portion to the small triradiates, with the addition, of course, of the fourth arm. No. 1, in its finer form, is confined to the peristome,

and the stouter one with lanciform end to the surface, the latter also mingling (as before stated to be the wont of the surface acerates) with the proximal ends of the peristome spicules; no. 2, the triradiates in their largest size occupying the position mentioned; and no. 3, the quadriradiates, mixed with the small triradiates, in the cortex and the cloaca respectively; in the latter, the fourth arm is short, small, and so sparse as to be hardly noticeable. Size of specimen, which of course, from its composition, is very irregular, about 1½ in. each way.

Obs. On the surface of the cloaca may be seen small holes about 1-1000th in. in diameter, which appear to be pores like those of the surface, as I have before stated; and here I would observe again that if the differences in form, position, and size of the spicules respectively in a Calcareous Sponge are to be severally noted, it must be done in a special description of the species itself, which would thus become far too elaborate for practical purposes, so that, in a Handbook of Sponges generally, some medium course must be adopted to attain this object.

23. *Heteropia macera.*

Agglomerate. Consisting of several individuals united together, whose form separately would be cylindrical, sacciform, and peristomed. Colour whitish yellow outside, sponge-brown within. Surface even, uniformly consisting of moderately large triradiates fixed in position by cribriform sarcode. Pores, the holes of the cribriform structure, which are very distinct but not particularly large. Vents of the individuals respectively terminal, circular, and each provided with a peristome, leading into a general cloacal cavity, which is narrow and cylindrical at first, but afterwards becomes wider than the wall of this cavity as it spreads itself out into the cloacal dilatations of the rest of the individuals in the mass; holes of the cloaca large generally, but still variable in size and distance apart, corresponding with the variable width of the skeletal structure of the surface of the cloaca. Structure of the wall like that of the last species described, viz. *H. patulosculifera*, that is, consisting of horizontal intervals defined by the long shafts of sagittal triradiates which, coming from opposite sides of the wall, overlap each other, while the intervals, which are chiefly composed of sarcode, intercommunicate with each other by large holes in addition to the usual pores. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates, of three forms, viz. that usually composing the peristome, among which proxi-

mally may be found shorter ones with lanciform ends; minute ones or mortar-spicules, both straight and sinuous, the latter with lanceolate ends, varying under 30-6000ths in. long, with which the cribriform structure of the surface is more or less charged; and, lastly, large and much curved fusiform acerates about 180 by 15-6000ths in., echinating the surface chiefly towards the mouth; 2, triradiates, of the surface generally, moderately large, regular and irregular, or sagittal; and of the wall much larger, where their shafts vary under 150 by 12-6000ths, with each of the arms a little less. No. 1, respectively, in its thin form confined to the peristome, in its minute one to the surface, where, in combination with the cribriform dermal sarcode, it fixes in the triradiates of this part; and the stouter form chiefly to the region of the mouth, where its much curved and thickened portion, which is outside, is directed towards this aperture, and its attenuated one sunk deeply into the *wall* of the specimen. No. 2, triradiates, to the dermal and cloacal surfaces and the wall; in the latter, their long straight shafts overlapping each other, as in the foregoing species, divide the structure into horizontal intervals, while their arms are much spread out sagitally under the spicular layers of the surface and of the cloaca. Size of largest group, for there are two specimens each consisting of several individuals of different size agglomerated, 2-3rds in. high by $1\frac{1}{2} \times \frac{1}{2}$ in. horizontally.

Obs. In this species that peculiar form of the sagittal triradiate is well developed wherein the shaft, which is, as usual, straight and cylindrical, is accompanied by a vertically flattened state of the two arms; so that *in situ*, that is on the lower and inner part of the peristome, where this form of the triradiate is particularly evident, the shaft is seen to be in a line with the spicules or palisading of the peristome, while the flat arms are spread out sagittally across them—thus acting, like the cross bar of a paling, in keeping flat and in position the lower ends of the palisading.

24. *Heteropia compressa.*

Agglomerate. Specimen in form massive, compressed, irregular, consisting of variously elongated conical processes projecting irregularly from the general mass; peristomed. Colour white outside, sponge-brown within. Surface even, consisting of cribriform sarcode, knitting together tolerably large triradiates with more or less uniformity; triradiates rather elevated in the centre. Pores, the holes in the cribriform structure, averaging about 1-900th inch in diameter, among which are scattered others (? excretory) full three times

as large. Vents single, terminal, peristomed, at the ends of the conical processes respectively; all leading into a general cloacal cavity, which is thus rendered wide, irregular, and compressed, in accordance with the form of the specimen; holes in the cloaca numerous, of different sizes and distances apart, the largest more or less sunk into the wall-structure, showing *within* again the openings of the chambers of the latter; surface of the cloaca smooth, or, if echinated, it is with one of the projecting arms of a triradiate, as there are no quadriradiates. Wall comparatively thin, composed of largely cancellated sarcode traversed by equally large triradiates, whose shafts, coming from opposite sides, cross it entirely, and whose widely spread-out arms support the structure of the surface outside and the spicular layer of the cloaca within respectively. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates, for the most part long, thin, straight, and cylindrical; 2, triradiates, regular and irregular, of two sizes, small and large, the latter far exceeding the other in this respect, averaging for the shaft 225 by 22-6000ths in., with wide-spread arms of nearly the same length, so that it approaches an equiradiate form. No. 1 confined to the peristome, where the shorter spicules are intermixed with the longer ones which are broken off; no. 2 to the surface of the body, the cloaca, and the wall-structure; those of the cloaca towards the mouth furnished, as usual, with *flat* arms, which, sagittally expanding across the inner ends of the peristome-spicules, bind the latter down to a common level, as before stated, like the cross bars of a paling, while the shaft, which may be insignificantly short and round, is directed perpendicularly backwards. Size of specimen 1 inch high by $1 \times \frac{1}{2}$ inch horizontally.

25. *Heteropia pluriosculifera.*

Agglomerate. Specimen in form irregularly triangular, rather compressed, consisting of three individuals or lobes, each of which is provided with a peristome; growing on a small branch of a *Fucus*. Colour whitish yellow externally, sponge-brown within. Surface uniformly composed of moderately large triradiates bound together by cribriform sarcode. Pores or interstices of the cribriform sarcode large. Vents single and terminal, situated on the prominent parts of the lobes respectively, each furnished with a peristome; leading to a common cloacal cavity, corresponding in shape with that of the specimen, but much wider than the wall, which, being only 1-33rd inch thick, looks also in this case like a mere shell

to it; holes in the cloaca numerous, variable in size and distance apart in proportion to the breadth of the intervening skeletal structure of this cavity; subcircular and presenting within respectively from one to four openings which belong to the structure of the wall. Structure of the wall like that of the foregoing species of *Heteropia*. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one long, straight, thin, and cylindrical, and the other slightly curved, stouter, and fusiform, the latter varying in size under 255 by 9-6000ths in.; 2, triradiates, small and large, the latter far exceeding the others in size, averaging 85 by 5-6000ths in. in the shaft, with arms 30 by 5-6000ths in. No. 1 in its thinner form is confined to the peristome, and in its stouter one echinates the surface generally, where its inner part, which is most attenuated, is deeply sunk into the wall, and its outer part, which is thicker, curved towards the plurality of mouths respectively; no. 2 in its smaller and more regular form is chiefly confined to the skeletal structure of the surface and cloaca, and the larger ones to the interior, where their straight long shafts, coming from opposite sides of the wall, overlap each other, as in the foregoing species. I saw neither quadriradiates nor mortar-spicules. Size of specimen about 4-12ths in. high by 7-12ths horizontally in its greatest diameter.

26. *Heteropia erecta.*

Agglomerate. Specimen erect, compressed, contracted towards the point of attachment, consisting of several individuals of different sizes sprouting out obliquely upwards from the general mass in conical forms, each provided with a peristome. Colour whitish yellow outside, sponge-brown within. Surface even, uniformly composed of moderately large triradiates, held in position by cribriform sarcode. Pores in more or less defined areas of the cribriform sarcode, bounded by the intercrossing arms of the dermal triradiates; large generally, but presenting two sizes, viz. one the most numerous, about 1-830th in. in diameter, and the other about 1-276th in., the latter scattered irregularly amongst the former. Vents single and terminal, at the ends of the conical individuals respectively, each furnished with a peristome, leading after a short distance from a narrow cavity in each conical portion to a general one much wider than the walls of the former, which are about 1-24th in. thick; holes in the cloaca very variable in size and distance apart, the latter corresponding in width

to that of the skeletal layer of the cavity which separates them; subcircular, presenting *within* respectively from one to four or more openings which belong to the wall-structure, so that each of these holes in the cloaca is the aperture of a subcloacal dilatation or cavity. Structure of the wall like that of *H. compressa*. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one thin, straight, cylindrical, fine, silky, and the other stout, fusiform, and much curved, averaging 240 by 18-6000ths in.; 2, triradiates, viz. those of the surface, which are moderately large, regular and irregular or sagittal, and those of the wall, which are very large and long-shafted, averaging 120 by 6-6000ths in., and the arms only a little less, so that this spicule also is very nearly equiradiate. No. 1 in its thin form is confined to the peristome, and in its stouter one echinates the surface chiefly towards the mouth, where its outer portion, which is the largest, is much curved, and the curve directed towards the mouth, while the other or more attenuated one is deeply sunk into the wall of this part; no. 2, the triradiates, in their smaller and more regular forms, are confined to the surfaces both of the outside of the specimen and the cloacal cavity, while the larger and less regular ones are confined to the interior of the wall, where their straight long shafts, coming from opposite sides, overlap each other, and their sagittal arms support the structure of the surface and that of the cloaca respectively. No quadriradiates or mortar-spicules were seen. Size of specimen, which is compressed, 9-12ths in. high by 5-12ths in. in its greatest diameter.

Obs. I notice here, as in other instances, that the most dilated spaces of the wall are under the surface and the cloaca respectively, thus presenting *subdermal* and *subcloacal* cavities. The physiology of all this, and much more too, will by and by have to be explained before the nature of the sponge is fully elucidated.

27. *Heteropia spissa.*

Agglomerate. Specimen triangular, rounded, each angle formed of the outer part of a conical individual connected with a common centre; growing upon a small branch of a *Fucus*. Colour whitish yellow. Surface even, composed of cribriform sarcode, fixing in a number of triradiates of different sizes, some of which are very large, and many with one arm projecting beyond the common level, especially towards the mouth. Pores consisting of the holes in the cribriform sarcode, which for the most part are uniform in size, viz. 1-830th in. in diameter, but here and there double this width.

Vents single, one at the end of each conical lobe, each provided with a peristome, and all leading to a dilated central cavity or cloaca, whose holes are variable in size and distance apart, corresponding to the breadth of the skeletal layer of this cavity between them; subcircular, and presenting *within* respectively from one to three or more openings which belong to the wall-structure. Structure of the wall, which is about 1-23rd in. thick, like that of the foregoing species, but with the sagittal radiates still larger. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one long, thin, straight, cylindrical, and the other minute, short, and also straight, averaging about 14 by $\frac{1}{3}$-6000th in.; 2, triradiates, of different sizes and different degrees of irregularity, sagittal and otherwise, the largest averaging 225 by 27-6000ths in., with arms respectively about 150 by 8-6000ths in. No. 1 is confined to the peristome in its long thin form, and in its short minute one sparingly to the cribriform sarcode, where it constitutes the mortar-spicule; no. 2, viz. the triradiate, in its smaller form, which is still comparatively large, is confined to the structure of the surface and that of the cloaca, where, in the former, one ray often projects in such a manner that, if not carefully examined, it may be mistaken for a large acerate directed towards the mouth, and the other form, which is much more sagittal, to the wall, where its shafts stretch across this part from opposite sides, and thus overlap each other, while their arms support the skeletal structures of the surface and cloaca. Size of specimen about $\frac{1}{2}$ inch in its widest diameter.

Obs. The chief characters of this specimen are its large triradiates, whose projecting arms on the surface seem to replace the large curved acerates usually found there; also the absence of quadriradiates, and therefore of echinating spines, on the surface of the cloaca.

[To be continued.]

VII.—*Professor E. Ray Lankester's Memoir "Limulus an Arachnid," and the Pretensions and Charges founded upon it.* By Professor CARL CLAUS.

IN a recently published article, in the April number of this Journal, entitled "Professor Claus and the Classification of the Arthropoda," Prof. E. Ray Lankester has taken upon himself to bring a series of heavy accusations against me, and asserts that I have borrowed from his *Limulus*-memoir of the year 1881 the views expressed by me upon the classification of the Arthropoda, on the occasion of a communication upon the heart of the Acarina, which appeared in the 'Anzeiger

der kais. Akad. der Wiss. in Wien,' for 17th December, 1885, and in the number of this Journal for February 1886. I venture to reply as follows to these charges :—

1. The communication published in the 'Anzeiger' upon the relations of the Gigantostraca to the Arachnoidea, on the unnatural character of the division into Branchiata and Tracheata, and on the classification of the Arthropoda, is essentially nothing more than a repetition of my opinion as already published years ago. Even in the work entitled 'Untersuchungen über die genealogische Grundlage des Crustaceensystems' (Vienna, 1876) I adhered to the views of those who, like Straus-Dürckheim, regard *Limulus* and branchiate Gigantostraca as allied to the air-breathing Arachnoidea, and the latter as having proceeded from the former, although, having regard to the possibility of a still undemonstrated Nauplius-stage, I considered it probable that the common origin with the true Crustacea was rather after than before the Nauplius-period of the Stem-Crustacean. In the case of *Limulus* and the Scorpions I also asserted the homology both of the six pairs of limbs of the cephalothorax and, with reference to the developmental history, of the six pairs of limbs of the præabdomen, of which the second pair represent the comb-like organ of the Scorpions, while the following four pairs immediately undergo retrogression (p. 110). In the 'Grundzüge der Zoologie' of the year 1880 I went so much further as to divide the Branchiata, or Crustacea *sensu latiori*, into EUCRUSTACEA (with the Entomostraca and Malacostraca) and GIGANTOSTRACA (with no certain traces of the Nauplius-stage), and accordingly I affirmed expressly of the Tracheata *that in opposition to the more ancient Branchiata they "were not referable to a unitary origin, since the Arachnoidea, which are derivable from the Gigantostraca, stand opposite to the Myriapoda and Insecta, which are united by a closer affinity"* (p. 515). This implied not only that the division of the Arthropoda into Branchiata and Tracheata is an artificial one, inasmuch as the branchiate Crustacea and the air-breathing Arachnoidea meet together in a common origin, but also the denial of the unitary origin of the tracheæ, and the contrast of two series of Tracheata, the Arachnoidea on the one hand, and the Myriapoda and Insecta on the other.

In his *Limulus*-article E. Ray Lankester has entirely ignored the contents of my work of the year 1876, and referring to the 'Grundzüge,' cited by him, but with the contents of which he was certainly unacquainted, he misrepresents my views by the incorrect statement: "of the relationships of the Gigantostraca to Arachnida Claus says nothing." Although I will not reproach Prof. Ray Lankester with being so ill-

informed as to my opinion when he prepared his *Limulus*-article, he certainly ought since then, and before publicly bringing such serious accusations against me, to have made himself better acquainted with my writings.

2. In the excess of his zeal it has quite escaped Prof. Ray Lankester that my conception is very different from his, and has nothing at all to do with the assertions and conclusions contained in the *Limulus*-article, so far as these are *peculiar to him.* Not only do I treat the derivation of the Scorpions from the Gigantostraca merely as a probable one, but I also in those words appeal, in the first place, only to the insufficient evidence of the Crustacean nature of the latter (Crustacean in the sense of the Eucrustacea), in order, in the next sentence, to seek the data for their relationship to the Arachnoidea in *developmental history.* Consequently, even without citing the *Limulus*-article, I exclude, as arguments, the supposed data derived from the perfect organism.

Or has Ray Lankester forgotten the criticism passed upon the contents of his *Limulus*-article by no other than Packard, the author of an important work on the development of *Limulus*? Has it passed from his memory that Packard has demonstrated his parallelizations, almost point by point, to be constructions of the imagination? (see S. F. Packard, "Is *Limulus* an Arachnid?" 'American Naturalist,' 1882). But even in this case he ought not to have overlooked the fact that I do not refer to the agreements deduced from the form and structure of the perfect organism, and from this he ought to have concluded at least that I have no great confidence in them.

Let us now look a little more closely into the contents of the celebrated *Limulus*-article and the other writings of Ray Lankester related to it, in order to judge of the value of the evidence for regarding *Limulus* as an Arachnid which they contain.

In opposition to Ray Lankester's assertion that *Limulus* and *Scorpio* agree, segment for segment, Packard has shown from the development that in *Limulus* there are not eighteen but only fourteen segments present, and consequently that four segments are added as "metaphysical inventions." "Our author," adds Packard, "sets out with the foregone conclusion that he '*must*' find in the abdominal carapace of *Limulus* the representatives of the twelve abdominal segments of the Scorpion; and so, with a method of his own, he creates them out of his inner consciousness." No better judgment is passed upon the homologization of the six pairs of limbs of the abdomen with the triangular sternite, the pectinate appendages, and the four pairs of lung-sacs of the Scorpion.

Although in accordance with my own comparison (published in 1876) I cannot see why the pectinate appendages cannot represent the second pair of limbs, I nevertheless entirely agree with Packard in regarding the attempt to refer the lung-sacs of the Scorpion to the introverted branchial laminæ of the last four pairs of limbs, as mere trifling with baseless assumptions. In point of fact this exceedingly remarkable speculation (which its author has, however, replaced by a new one) furnishes us with a not very edifying example of the ingenious hypotheses into which an unbridled imagination may lead the morphologist.

It fares no better with the assertions as to the agreement between the brain, nervous system, and eyes in the two types. Packard shows Lankester to be in error when he shifts the origin of the pair of nerves which run to the anterior extremities in *Scorpio*, from the brain, as in *Limulus*, to the œsophageal ring; and in the same way he disputes the interpretation adopted by Ray Lankester to enable him to homologize the scattered simple eyes of the Scorpion with the lateral facetted eyes of *Limulus*.

This, however, by no means exhausts the list of errors and fallacies. *Limulus*, like the Scorpion, possesses a supra- or circum-medullary artery, which issues from the aorta and embraces the œsophagus. No Crustacean, says Ray Lankester, has such a spinal vessel, consequently *Limulus* is an Arachnid. But is our author so imperfectly acquainted with the anatomy of the Crustacea as to have no knowledge of the vascular system of the Isopoda, in which there is a peri-œsophageal annular vessel, which issues from the aorta and receives blood from it? In my work upon the organs of circulation in the Schizopoda and Decapoda (Vienna, 1884) I have even attempted to show the probability that this condition was perhaps the original one in the ancestral forms of the Thoracostraca.

And now as to the supposed perfect agreement in the form and minute structure of the organs to which Ray Lankester appeals as an argument for *Limulus* being an Arachnid! And first of all the possession of reticulate sexual glands, which are said not to exist in the Crustacea. Does not Ray Lankester know the reticulate testes of the genus *Apus*, a genus which he made the subject of an extensive memoir? And is he so little able to judge of the morphological significance of a character as to estimate, from a classificational point of view, the external form of the sexual glands as a determinant factor in making *Limulus* an Arachnid? What have the comparisons of the leg-glands (the so-called *coxal glands*), which are quite arbitrarily interpreted as segmental organs, to do with the proof that *Limulus* is an Arachnid? or, lastly, the structure of the so-called *entochondrites* and inner skeletal structures in *Limu-*

lus, *Scorpio*, and *Mygale*, especially as perfectly similar endoskeletal structures occur also in the Crustacea?

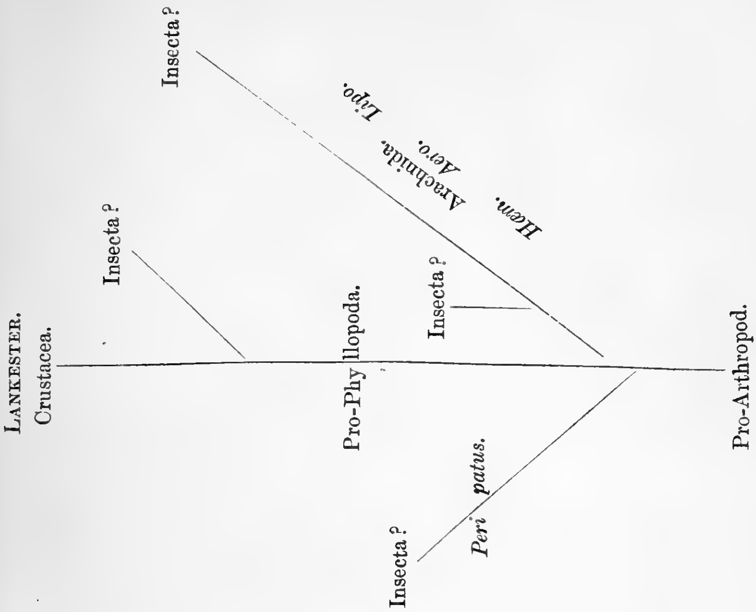
Under such circumstances it will hardly be a matter of wonder if I was unable to recognize in Ray Lankester's *Limulus*-article any advance towards a solution of a problem which has been extant for years, but rather felt compelled to regard it as a failure, so far as it went beyond what was known to his predecessors. Consequently if, in my short communication in the 'Anzeiger' of the Academy, I had been able to include any statements upon the literature of the subject, I should certainly have cited Ray Lankester's article only in the above sense, and to show how hasty speculations may shoot beyond the mark. I may, however, admit freely that in the preparation of my short note I had not the least thought of Ray Lankester's *Limulus*-memoir, especially as my conception of the relations of the Gigantostraca to the Arachnoidea dates much further back, and has nothing at all in common with all the speculations, assertions, and conclusions of the English author.

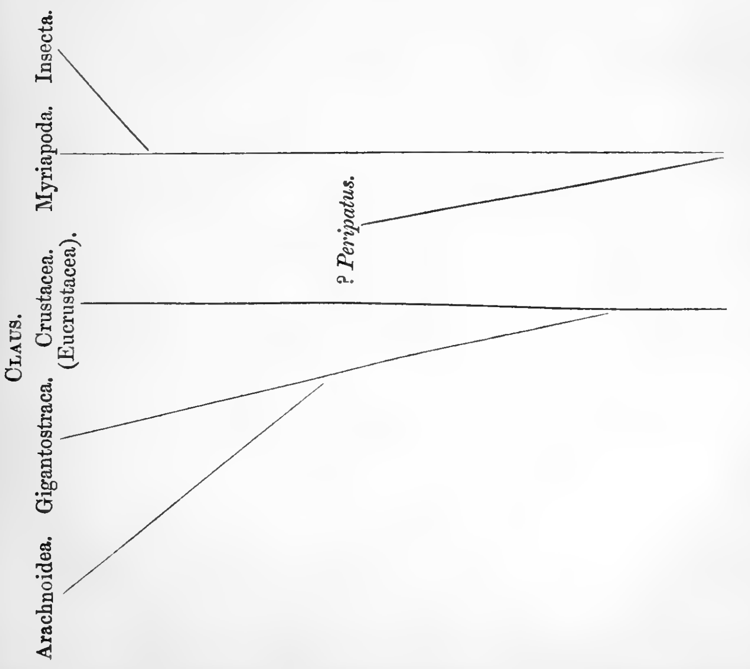
Had Ray Lankester been able to treat the few words of my communication with quiet consideration it would have been quite impossible that the contrast of the two views should have escaped him so completely; with the acuteness peculiar to him he must at once have recognized that I assert something quite different from his conclusions when I arrange the Gigantostraca and the Arachnoidea as descending from them *as different classes in a genetic series*, while he himself would prove *Limulus* to be an Arachnid, and imagines that he has proved it. I regarded the relationship of the Xiphosura and Arachnoidea *as a more distant one*; and by placing the Gigantostraca and Arachnoidea in one of the three Arthropod series I by no means affirm the *Arachnoidal nature* of *Limulus* any more than I would maintain the Insect nature of *Peripatus*, which, as a representative of the Onychophora, I placed, with the Myriapoda and Insecta, in the other series.

3. It must appear quite unintelligible that Ray Lankester was not aware of the great differences which exist between him and myself as to the mode of derivation of the classes of Arthropoda, as also of the contradiction in the interpretation of the antennæ, so that he could do my views the honour of regarding them as almost, point by point, adopted from his own. When I asserted in my communication: "Hitherto, evidently, far too much stress has been laid upon this latter agreement [respiration by tracheæ] in the unfortunate division of the Arthropoda into Branchiata and Tracheata" (and the same thing was previously said in the 'Grundzüge'), "without considering that the breathing by air-spaces may have been developed in different ways," &c., this of course,

according to Lankester, is "simply repeating a statement by me" &c.; and when I remark, "Accordingly the roots of the old Gigantostraca and Xiphosura may meet in a common origin" &c., and further, "Besides these two series of Arthropoda, probably united at the base, we have then to distinguish, as a third series of forms, that of the Insecta and Myriapoda, for the derivation of which the remarkable Annelid-like Onychophora (*Peripatus*) appear to be possibly of great significance,"—opinions which, as shown above, are already contained in the 'Grundzüge,'—our author does not hesitate to comment as follows upon these statements:—"Proceeding to formulate the conclusions *which he has taken bodily from me* as to the probable genealogy of the chief groups of the Arthropoda, Prof. Claus states that the stem of the Crustacea and that of the Arachnida are united at the base, whilst the Insecta Hexapoda and Myriapoda form a third series, 'for the derivation of which the remarkable Annelid-like Onychophora (*Peripatus*) appear to be so significant.'" I will here take no notice of the misrepresentation which my expression with reference to the Onychophora has undergone in the English translation cited by Lankester by the omission of the word "possibly," by which I wished to indicate that the Onychophora-question is still an open one*, and will confine myself to the demonstration of the difference of this derivation from the genealogical tree which Ray Lankester has sketched in his *Limulus*-article. He says, indeed, "This is a simple and direct description in words of the genealogical tree of the Arthropoda at the end of my article '*Limulus* an Arachnid,'" but unconsciously gives up this opinion in the following phrase, which runs:—"with this difference, that whilst I have represented the Crustacea and the Arachnida as two main stems with a common base, and *Peripatus* as a third and independent stem, I have indicated a hesitation to decide on referring the Insecta Hexapoda and Myriapoda to the stem of *Peripatus* absolutely, and have considered the possibility of their derivation from either the Arthrostracous Crustacea or the tracheate Arachnida." If I wished to embody the genealogical affinities of the three established Arthropod series in the form of a genealogical tree I should have to choose some such scheme as the following, which, as will be seen from the copy of Ray Lankester's genealogical tree of the Arthropoda placed beside it, presents a somewhat different appearance:—

* [The quotation in Prof. Lankester's paper was taken from the abridgment of Prof. Claus's note in this Journal, so that the omission of the word "possibly" is hardly to be charged upon Prof. Lankester. To us the "möglicherweise" seemed quite unnecessary, and indeed redundant, in the case of a group which only "appeared" to be of great significance; it certainly did not convey the idea above ascribed to it.—EDS.]


LANKESTER.
Crustacea.
Insecta?
Insecta?
Pro-Phyllopoda.
Insecta?
Hem.
Arachnida.
Aero.
Lipo.
Insecta?
Peripatus.
Pro-Arthropod.


CLAUS.
Insecta.
Myriapoda.
? *Peripatus.*
Crustacea.
(Eucrustacea).
Gigantostraca.
Arachnoidea.

The interpretation of the antennæ also I am said to have taken from Prof. Ray Lankester's writings! In his Cell-layer publication of the year 1873 our author has set up the beautiful hypothesis * of the change of position of the buccal aperture in the Arthropoda in order to explain a second supposition of his, according to which the prostomium of the Arthropoda is formed exclusively by the eye-segment. Ray Lankester consequently assumes that the antennal segments were originally placed metastomially, and only became prostomial by a subsequent shifting of position of the oral aperture. In what way, and induced by what causes, the formation of the new mouth took place we unfortunately do not learn; but we are told that this assumption is *fully warranted* by Kowalewsky's investigations upon *Amphioxus*, because, according to his observations, the mouth of *Amphioxus* is the first gill-slit or pharyngeal perforation on the left side, and has no relation to the primary larval mouth &c. (see footnote). Thus it is a completely false analogy which is supposed to furnish the foundation for the notion of the "adaptational shifting of the oral aperture," and justify the interpretation of the Arthropod antennæ as postoral limbs. And yet Ray Lankester ventures now to call this completely futile speculation a *fundamental theory*, from which I am supposed to have borrowed the interpretation of the second Crustacean antenna as a body-appendage! Subsequently, in the *Limulus*-article and that on *Apus* of the year 1881, the postoral nature of the antennæ is again affirmed, but only for the Crustacea;

* This fine passage runs as follows:—"Much more likely it seems is the explanation that the oral aperture shifts position, and that the ophthalmic segment alone in Arthropoda represents the prostomium, the antennary and antennular segments being aboriginally metastomial, and only prostomial by later adaptational shifting of the oral aperture." And further on (but upon this he has, perhaps wisely, said nothing): "The assumption of such a shifting of the oral aperture is fully warranted by what has been demonstrated in the case of Vertebrata through Kowalewsky's researches on *Amphioxus*. It is certain from those observations that the mouth of *Amphioxus* is the first gill-slit or pharyngeal perforation of the left side, and has no relation to a mouth such as that which appears at an earlier stage of development in the allied Ascidian larva, which latter mouth is that of Vermes generally. *Amphioxus* then and the Vertebrata have a new oral aperture, the old one being gradually suppressed. Comparative osteology and the embryology of higher Vertebrata have long made it clear that the vertebrate mouth belongs to the series of visceral clefts; but the significance of this in the comparison of Vertebrata and Invertebrata has yet to be fully appreciated. The identification of the neural and hæmal aspects of Vertebrata and Vermes in the light given by this demonstration of Kowalewsky's, as to the distinct character of the mouth in the two cases, must lead to most valuable results."

and it is admitted to be possible that the antennæ of *Peripatus*, as also of the Hexapoda and Myriapoda, are true appendages of the prostomium, as in the Chætopoda!

On the other hand, for my own part, even in my earlier writings, I have regarded the anterior antennæ of the Crustacea as prostomial appendages equivalent to the antennæ of Insects, Myriapoda, and of *Peripatus*, and subsequently, in agreement with Hatschek, as derived from the frontal tentacles of the Annelida, but have attached to the second pair of antennæ of the Crustacea the significance of a pair of body-appendages only secondarily shifted in front of the mouth; and this since I ascertained in many Entomostraca the origin of the nerves of the second antennæ far away from the cerebrum upon ganglia of the œsophageal ring, and at the same time took into consideration the paraoral position of these appendages in the Nauplius-larvæ. Not a change in the position of the mouth, as supposed by Ray Lankester, but an upward movement of the appendages performed in the course of development, with a corresponding displacement of the place of origin of the nerves belonging to them, was recognized as the argument for the preoral shifting of the second antenna and the origin of its nerve on the cerebrum.

When Ray Lankester states that he has not hitherto found this doctrine of an upward movement clearly formulated in my writings, this only proves once more that he does not know them very well. In the 'Grundzüge' indeed, in which the whole domain of zoology is treated in the most condensed form, no discussion of such a point is to be expected; but Ray Lankester might have expected to find something of the kind in the "Beiträge zur Kenntniss des feineren Baues der Daphniden &c.," Zeitsch. f. wiss. Zool. xxvii. (1876), and would have found it had he looked (pp. 377–379). Instead of this he comes forward at once with the charge:—"He has adopted my theory of 1873 in so far only as the second pair of antennæ are concerned;" nay, more, he does not shrink from the really enormous logical contradiction of characterizing my views as to the Arthropod antennæ ("as to the contrasted and totally distinct origin of the Crustacean antennæ") as adopted from his writings!

How is it possible, moreover, that, considering the contradiction in the interpretation of the Crustacean antennæ and the anterior limbs of the Gigantostraca and Arachnoidea, Ray Lankester should be unable to comprehend that my explanation is quite different from his, and therefore even for that reason alone cannot be borrowed from him? While he interprets the falces (or so-called "jaw-antennæ") of the

Arachnida and the anterior limbs of *Limulus* as equivalent to the anterior antennæ of the Crustacea, I characterize the Arachnoidea and Gigantostraca by the absence of the anterior antennæ, which I correlate with the antennæ of Insects, Myriapods, and *Peripatus*. Formerly indeed, in my work upon the Crustacean system, I correlated the anterior members of *Limulus*, like the falces of the Arachnoidea, with the anterior antennæ of the Crustacea; but this interpretation was founded upon the erroneous notion, supported by the statements of authors, that the nerve belonging to them originates from the cerebrum. But since I became acquainted with the demonstration given by Alphonse Milne-Edwards, that this nerve, in opposition to the statements of Van der Hoeven, Owen, and Huxley, really originates from the œsophageal ring, I regard the interpretation of the anterior pair of members as belonging to the trunk as incontestable, while, on the other hand, I can see no obstacle to the homologization of the falces with the anterior limbs of *Limulus*, in the circumstance that the nerves passing to the falces of the Scorpions originate from the cerebrum, considering the other reasons in favour of the morphological relationship of the Gigantostraca and Arachnoidea. Just in the same way that the nerve of the second antenna of the Crustacea, originating from the œsophageal ring, becomes a cerebral nerve in the higher types of that class, a similar condition may also be developed in the second Arthropod series, and the nerve originating from the cerebrum in the higher type of the Arachnoidea may have belonged, in the Gigantostraca, as still in *Limulus*, to the œsophageal ring, and consequently to a trunk-ganglion; in other words, the nerve of the falces of the Arachnoidea has only secondarily become a cerebral nerve. From this mode of argumentation, which is quite different from Ray Lankester's, I have characterized the second Arthropod series by the reduction of the præoral region of the head and *the deficiency of the first pair of antennæ*, without the least reference to any opinions of Prof. Ray Lankester, with which mine have nothing in common. How complete this contradiction is, especially in the province of the Crustacea, Ray Lankester may ascertain from my investigations of recent date, which, indeed, appear to be equally unknown to him with the earlier ones. If Ray Lankester had only a remote presentiment of this contradiction, which is founded on the whole method of putting forward the question, on the mode of investigation and drawing conclusions, he would certainly have kept himself free from the apprehension that on the next favourable opportunity I might perhaps appropriate

from him the notion that the first Crustacean antenna is a postoral member. "I do not think it improbable," he does not hesitate to say, "that at some future date Prof. Claus may adopt the view which I have advocated as to the first, just as he has adopted it in regard to the second pair of Crustacean antennæ; and I am therefore anxious to take the present opportunity of insisting upon an important piece of evidence in its favour which has come to light through my researches on the relationship of *Limulus* to the Arachnida." Then follows a precious piece of argumentation, which furnishes a striking evidence as to the method of work adopted by our author, and by which the postoral interpretation of the anterior Crustacean antenna is to be proved. The "brick-red glands" of *Limulus* and the corresponding coxal glands of *Scorpio* and *Mygale* are segmental organs, and, indeed, according to Ray Lankester's latest investigations, the equivalents of the shell-glands of the Entomostraca, which, as is well known, open outwards on the second pair of maxillæ. Now, according to Gulland's and Kingsley's statements, the brick-red gland of the young *Limulus* opens in the basal joint of the fifth pair of appendages; consequently this pair of limbs corresponds to the second pair of maxillæ of the Entomostraca; and as this also represents the fifth appendage, the first pair of appendages of *Limulus* and the Arachnoidea represents the first pair of antennæ of the Crustacea, consequently this is the first postoral pair of appendages, *quod erat demonstrandum*! If the "brick-red gland" of *Limulus* were really homologous with the shell-gland of the Crustacea, the Arachnid theory of *Limulus* would be in a truly bad way!

In the preceding statement I have not only proved the falsity of the charges which Prof. Ray Lankester has brought against me, but I also believe that I have demonstrated the method which he has employed in order to make these charges seem plausible to the impartial reader who may not be thoroughly well informed upon the subjects. It is the same method which the honoured English author makes use of in his scientific works in order to build up the famous results of his remarkable deductions by means of the most extraordinary speculations without a sufficient foundation of facts. But while these must often serve to amuse the judicious reader, the grave charges against a colleague have a very serious side. Now that the proof of their absolute falsity has been given, the reproach of at any rate *frivolous suspicion* falls all the more heavily upon the originator of the accusations—a reproach from which a respectable man can only clear himself by simple and honourable revocation.

VIII.—*Remarks on Dr. Hamann's Researches in the Morphology of the Echinoidea.* By Prof. P. Martin Duncan, F.R.S. &c.

Dr. Hamann was good enough to send me a copy of his very interesting and valuable "Vorläufige Mittheilungen zur Morphologie der Echiniden" *; it arrived whilst I was engaged in the study of the histology of some of the same structures which have been so well described by him, but in another group of genera. I venture to make the following observations on two of the subjects which have especially been considered by Dr. Hamann.

I. *The Globiferen.*

These organs are a discovery of Dr. Hamann's, and, as might have been expected from his former work on the Holothuroidea, they are clearly described and are therefore readily recognized.

But the diagram given by Dr. Hamann of a globifer of *Sphærechinus granularis* is rather misleading, and the real organs would hardly be recognized therefrom. The three "Drüsenballen" are more united at their common base than the diagram indicates, and the upper ends are more or less constricted and have very large foramina for the exit of the mucus. The three masses are really continuous by their outer coat at their bases and rest upon a shorter stem than that shown in the figure. In fact, owing to the diagram I overlooked these organs in the first instance; and so did a fellow-worker. But when a number of tripartite bodies fixed on short stalks, and which looked like stunted ordinary pedicellariæ globiferæ (=gemmiformes) of *Sphærechinus*, had been separated from the test and examined, their identity with the organs described by Dr. Hamann and their distinctness from the ordinary pedicellariæ became evident.

There is no glandular enlargement of the shaft in the newly-described structures, and the stem, otherwise like that of a pedicellaria, springs from the test and has the usual soft structures at its origin. The head has three parts united at the base, very tumid inferiorly and slightly roundedly angular at the inner part, and much more rounded above than any

* Sonder-Abdruck aus den Sitzungsberichten der Jenaischen Gesellschaft für Medicin und Naturwissenschaft, Jahrg. 1886; Ann. & Mag. Nat. Hist. 1886, vol. xvii. pp. 388, 469.

pedicellariæ. Presenting the general appearance of one of the pedicellariæ so well described by Sladen (Ann. & Mag. Nat. Hist. August 1880, p. 101, pls. xii. and xiii.), but without the glands around the long stem, without any calcareous valves within the lobed structures, and without any protrusion of calcareous nature through the large foramen, the simplest examination enables the histological elements described by Dr. Hamann to be seen. As Dr. Hamann has stated, there is the outer epithelial coat, and beneath it connective tissue with C-shaped spicules, with, so far as I could see, but few nerve-fibres, and the close layer of muscular fibres noticed by Dr. Hamann. The mucus-gland layer, with its nucleated cells and granules, is largely developed. In one happy, thin, transverse section the remains of a partition, partly bisecting the mass vertically, was evident. The head of the "organ" obviously consists of three great mucus-glands united at their bases and free above, and the opening is surrounded by a sphincter. It is but just that I should state that, although these special gland-sacs on stems have been discovered and doubtless will be admirably described by Dr. Hamann, the morphology of the gland-sacs and their coverings was familiar to me, for it is the same as that seen in the pedicellariæ which formed the subject of Sladen's essay, the distinction between the two kinds of organs being of course the presence of the calcareous valves and the tactile cushion and the less globular shape of the pedicellariæ, which, moreover, invariably have three glands around the long stem.

In some of the bodies which one would have considered to be Dr. Hamann's organs without doubt, I found *exceedingly atrophied calcareous valves in the tumid "Drüsenballen."* The valves were very reticulate and delicate in the extreme; but the sharp points and the relics of the curved basal parts remained. The gland-structure was that described by Dr. Hamann, and there were no tactile cushions to be seen. The foramen was large and had the usual sphincter; there were no glands around the short stem.

I must confess that this finding of an atrophied series of valves, whilst it indicates the direction in which the nature of the new organs should be sought, also diminishes the interest one felt disposed to take in them. It must be remembered that Sladen distinctly states (*op. cit.* p. 108) that the pedicellariæ globiferæ (=gemmiformes) give forth mucus, and he described their glands. Hence it is correct to state that in function the organs just discovered and the long and valve-headed pedicellariæ are partly similar; the latter, being the more highly organized, have a clasping and tactile power,

besides the ability to excrete mucus, whilst the former are mucus-secretors *par excellence.*

It appears to me that the organs described by Dr. Hamann are modified pedicellariæ. There appears to be great variation in the morphology of the mucus-secreting organs in the Echinoidea, and whilst the organs described occur in numbers in half-grown *Sphærechini,* they appear to me to diminish in numbers in larger forms. The name "globiferi" is unfortunate, for so many echinodermatists follow O. F. Müller, and term the long-stalked and big-headed pedicellariæ *p. globiferæ.*

In order to prevent confusion, as the ground is occupied, it would be as well if Dr. Hamann would alter the name of the interesting organs he has discovered.

II. *The Termination of Nerves in the Echinoidea.*

Having been practically interested in this subject, and having traced the ending of nerve-fibres in the tentacles of some Echinida, it was necessary to recognize the work of former observers. In the midst of my work I had the opportunity of verifying Sladen's statements (*op. cit.* p. 107, and pl. xiii. fig. 12) and of examining his microscopic preparations. He stated with regard to the tactile cushions on the inner surface of the calcareous valves of the pedicellariæ globiferæ: "These organs, which are finely papillate and richly supplied with nerve-fibres (as will be found indicated in the section in pl. xiii. fig. 12), are presumably of sensorial (*i. e.* tactile) function, and act as the communicators of the advent of any foreign or irritating elements." The drawing shows, what can be well seen in the thin section, a number of parallel nerve-fibres coming to the surface from out of a layer of nucleated cells. The surface has a very delicate flat epithelium raised here and there into setiform projections. The drawing speaks for itself, and the similarity of the structures represented and those which were described and figured some years afterwards by Sven Lovén is remarkable. I have seen the same structure in *Cœlopleurus Maillardi* and cannot consider the drawing otherwise than correct.

Lovén, in his wonderful work on the genus *Pourtalesia* ('Kongl. Svenska Vetenskaps-Akademiens Handlingar,' Bd. xix. no. 7, 1883, pp. 45 to 55, pl. ix.), described and figured, with his usual great accuracy and art, the terminations of the pedicel-nerves. In fig. 82 the setæ and the expanded nervous structure at the tip of the fibre are distinct, and in figs. 86, 87, 89, and 90 the relation of the nerves to the sur-

face tissue can be well seen. It does not appear to be correct to state that no observers had described or figured the terminations of nerves in the Echinida before the writer of the interesting little preparatory essay which I have ventured to praise and criticize in a most friendly spirit.

June 1886.

BIBLIOGRAPHICAL NOTICE.

Memoirs of the Geological Survey of India. Palæontologia Indica, being Figures and Descriptions of the Organic Remains procured during the Progress of the Geological Survey of India. Published by Order of His Excellency the Governor-General of India in Council. Ser. x. *Indian Tertiary and Post-Tertiary Vertebrata.* Vol. III. Part 6. *Siwalik and Narbada Chelonia.* By R. Lydekker, B.A., F.G.S., &c. With 10 plates (xviii.–xxvii.). Calcutta: Geological Survey Office. London: Trübner & Co. 1885.

In a brief introduction Mr. Lydekker dwells on the difficulty of dealing with his material, a difficulty which may not be altogether unconnected with the variations of form which the Chelonian carapace often assumes with increasing age in existing species. Many of the Upper-Tertiary tortoises from the Siwaliks prove to be closely allied to species which still inhabit India and adjacent countries, though the terrestrial types are specifically distinct from living Indian species. The remains found in the more recent Narbada beds are all referred to existing Indian types.

The descriptions open with an account of additional remains of *Colossochelys atlas.* Among these the epiplastron is remarkable for its anterior bifurcation, a character which serves to distinguish it from the gigantic living tortoises. The xiphiplastron suggests, when taken with the other remains, that the carapace was about 8 feet long, while smaller specimens, which the author regards as probably female, may have been 6 feet long. The carapace, long ago restored by Falconer, shows that the pygal plates, as in the existing *Manouria emys,* were not united. The shaft of the humerus agrees best in proportion with the living Galapagos tortoise, *Testudo elephantopus.* The fragment indicates a bone 2 feet 4 inches long. A cranium is figured and provisionally referred to this species, which resembles that of *Testudo ponderosa* of Aldabra in its deeply concave palate, which is narrower than in *T. elephantina.* The head is estimated to have been over 9 inches long. From various resemblances the author is led to the conclusion that the Aldabra tortoises are probably descendants of the old Indian stock.

The remains next described are such that no attempt is made to characterize the genus to which they belong; and the species are indicated by numbers. Number one is about half as large again as *Testudo elephantina*, and is known from its epiplastron, which is about intermediate in character between that of *Colossochelys atlas* and the epiplastron of *Manouria emys*. A second species, also indicated by an epiplastron, is about one fourth larger than *Testudo elephantina*. To this type the marginal plate described as *Cautleya annuliger* may possibly be referred. The third species is another Punjab form, only known from the epiplastron. The fourth species, which is rather smaller than *Testudo elephantina*, is known from the epiplastron and one or two other bones, including the nuchal scute. Unlike the species one, two, and three, this type is related to the existing land-tortoises of India and Burma.

The author then treats of seven species which are referred to the genus *Clemmys*. They are arranged as having—first, no keel on the carapace of the adult; secondly, as marked by three continuous keels; and third, with three interrupted keels. Under the first head are placed *Clemmys sivalensis* (Theobald), *C. hydaspica*, *C. Theobaldi*, and *C. punjabiensis*. *Clemmys hydaspica* is closely allied to *C. sivalensis*, from which it appears to differ chiefly in the form of the first vertebral shield. *C. Theobaldi* shows the first vertebral shield, remarkable for the prolongation of the anterior angles of its pentagonal form. The author remarks that there are indications that costal keels, which have become practically obliterated, existed at an early age. *C. punjabiensis* is remarkable for the subquadrate form of the vertebral plates. It most closely resembles the North-American *C. ventricosa*; but the Indian types all have the carapace more elevated than any of the North-American species. The fifth species is not named, but stated to be allied to *Clemmys trijuga*; it has three indistinct obtuse keels, and is distinguished by the form of the vertebral plates. *Clemmys palæindica* has three interrupted keels, and shows a general resemblance to *C. Hamiltoni*, which is found in Lower Bengal. In the living form the vertebral plates are wider than long; but in the fossil their relative length is greater.

The genus *Pangshura* is represented both in the Narbada and Siwalik beds by the *P. flaviventris* (Günther). A second species, numbered 2, from the Siwaliks, is regarded as being related to *P. tentoria* and *P. tectum*. Five species of the genus *Batagur* are described. One, *Batagur Falconeri*, is allied to the *B. thurgi* of Gray; *B. Bakeri* is allied to *B. kachuga* (Gray); *B. Durandi* is allied to *B. dhongoka* (Gray); and in all these cases the fossil is regarded as the ancestor of the existing form. The fourth species is imperfectly known, and the fifth, *B. Cautleyi*, is distinguished by the shortness of the fourth vertebral plate, and it differs from *B. Durandi*, with which the author compares it. It is most nearly related to the living *B. affinis* and *B. pictus*. A fragment showing a triangular nuchal scute is referred to the genus *Geoemyda*.

The Trionychidæ are represented by three genera—*Emyda*,

Trionyx, and *Chitra*. *Emyda vittata* (Peters) is still found living in Ceylon, Southern and Central India. The new species are *Emyda lineata*, remarkable for the linear arrangement of its granular ornament; *Emyda sivalensis*, distinguished by being twice as large as the existing species; and *Emyda palæindica*, also founded on fragments. *Trionyx* is represented by three species, of which one is referred to the *T. gangeticus* of Cuvier, and the other two are unnamed. Finally, the *Chitra indica* (Gray), which ranges from the Ganges to the Malay coast, completes the account of the tortoises from the Siwalik hills.

The Chelonia are one of the most neglected groups of extant reptiles, and hence any attempt to deal with the fossil forms encounters difficulties in requiring research into the variableness of existing forms, and the grounds for classifications which have been adopted. The opportunity for writing a monograph like that which we notice might perhaps have justified such research; but failing it, we can only express gratification that the materials in the British Museum are made known in this handsome form.

MISCELLANEOUS.

On the Question of the Existence of Different Plasma-layers in the Soft Body of the Rhizopoda. By Dr. A. Gruber.

A question which has been frequently discussed is that as to the presence in the soft body of the Rhizopoda of separate plasma-layers, and the consequently more complex structure of those low Protozoa. The decision of this question is of interest because it is among the Rhizopoda that we have probably to seek the starting-point of the higher Protozoa, and because thereby it would be settled whether a unicellular organism may be competent to the performance of the most important physiological functions even if its protoplasm constitutes a perfectly unitary mass not separated into different regions, or whether this is not the case. I have here to state definitely that no division of the Rhizopod-body into zones sharply differentiated morphologically and physiologically occurs, and that the interpretations which have been made in this sense are decidedly founded upon illusions.

I will here mention only two authors who have gone furthest in this direction, and in the first place Maggi, who distinguishes not only an ecto- and an endoplasm, but also a mesoplasm *, in the last of which are seated the secretory organs of the Rhizopoda, namely the contractile vacuoles, while the ectoplasm has to serve for locomotion

* "Studi anatomico-fisiologici intorno alle Amibe, ed in particolare di una innominata," in Atti Soc. Ital. Sci. Nat. vol. xix. fasc. 4.

and the endoplasm for digestion. From the former therefore the pseudopodia originate; in the latter lie the incepted nutritive materials, and the nucleus is also contained in it.

Brass * goes still further, distinguishing in the Rhizopod-body, and, indeed, in the Infusoria and the animal-cell generally, four kinds of plasma, namely (proceeding from within outwards) the nutritive plasma, the food-plasma, the respiratory plasma, and the motor plasma. Brass's statements have already been sharply refuted by Bütschli †, and I may therefore here content myself with referring to this memoir, although it relates chiefly to the Infusoria. Bütschli's objections in fact, in my opinion, equally apply to the part of Brass's work which relates to the Rhizopoda.

Whoever has long busied himself with the study of the Rhizopoda knows how many species there are, especially among the *Amœbæ*, in which, during life, no division into separate zones occurs—in which the whole of the contained bodies, as well as the nucleus and vacuoles, are irregularly whirled about, so that, for example, the nucleus or the nuclei may be at one time pushed to the extreme periphery, and then again flow back into the centre of the body. If in such Rhizopoda, after the application of any reagents, an apparent separation into different plasma-layers occurs, this may be definitely regarded as artificially produced, in the face of the conviction arrived at during the life of the animal. But even during life in many species, especially the tough ones, an apparent division at least into two layers is often to be observed; this, however, as stated, is only apparent, and is due to the fact that the granules and vacuoles of the plasma group themselves chiefly in the middle of the body, and do not easily make their way into the processes given off; in reality there is here also only a unitary plasma-mass, and the apparent stratification may disappear at any moment. In the shelled Rhizopoda also a formation of regions frequently occurs, produced in this way:—the granules and nutritive constituents occupy only the anterior or the middle part of the body, and the other parts then stand forth as hyaline zones; but here also there is no true stratification, for in division, as I have shown ‡, the whole of the plasma of both divisional halves is completely mixed together.

I may remark particularly that this conception of the Rhizopod-body does not rest merely upon my personal conviction, but that it was expressed long since by, among others, an English student of the Protozoa, Wallich §, and recently demonstrated positively by the most competent authority in this department, Bütschli ‖, in

* 'Die Organisation der thierischen Zelle,' i. and ii.

† "Bemerkungen über die Schrift des Herrn Arnold Brass &c.," in Morphol. Jahrb. Bd. xi.

‡ "Der Theilungsvorgang bei *Euglypha alveolata*," and "Die Theilung der monothalamen Rhizopoden," in Zeitschr. für wiss. Zool. Bd. xxxv. and xxxvi.

§ Ann. & Mag. Nat. Hist. vols. xi., xii., and xiii. (1863-64).

‖ Bronn's 'Klassen und Ordnungen der Protozoen,' pp. 98, 99.

Bronn's 'Klassen und Ordnungen des Thierreichs.' Bütschli asserts justly that in all marine Rhizopoda, the Perforata and a great part of the Imperforata, the entire soft body is composed of completely homogeneous plasma, and that in the Amœbæ and Monothalamia already mentioned by me no sharp line of demarcation exists between the hyaline ecto- and the granular endoplasm, "as indeed is clear from the fact that in certain Amœbæ, and also in *Pelomyxa*, in which usually no ectoplasm can be distinguished, under certain circumstances such a hyaline external plasma-layer makes its appearance, and this consequently must have been produced from the granular plasma in the same way in which, locally bounded, a hyaline pseudopodium is evolved from the body of a Rhizopod consisting of granular plasma."

I think I have now said enough upon this point, especially as I have gone into it in detail in a more complete memoir on Amœbæ * ; and I would here now only call attention to one thing, namely the external limitation of the Rhizopod-body. This, as is well known, is naked, therefore not surrounded by any cuticle; but it would appear that by contact with water a stiffening of the plasma at the periphery takes place, preventing its deliquescence, and also causing an immediate closure of the cut surface in cases of artificial division. When the protoplasm issues forth in a broad process in the form of pseudopodia, the firmer bounding portion dissolves in the advancing plasma to become re-formed at the same moment. Usually this envelope is not perceptible even with the highest powers; but in some Amœbæ, with a particularly tough slowly-flowing plasma, it frequently attains a demonstrable thickness. This opinion also I have put forward more in detail in previous writings, and I revert to it here chiefly because, in my first memoir relating to this point †, I overlooked, and in the second, while mentioning the fact ‡, I did not give it sufficient prominence that long before me Wallich § had set up and established exactly the same theory; his view perfectly agrees with mine, and he has also given an explanation of the production of the nutritive vacuoles by assuming that a drop of water is carried in with the nutritive bodies, and that exerts the known stiffening action upon the portions of plasma surrounding the bodies, so that thus every nutritive vacuole appears to be lined with an ectosarcal layer. I think it may be regarded as strong evidence in favour of the opinion here expressed that the English naturalist and myself have come to exactly the same result quite independently of each other.—*Biologisches Centralblatt*, Band vi. p. 5, March 1, 1886.

* "Studien über Amöben," in Zeitschr. f. wiss. Zool. Bd. xli.

† "Beitr. zur Kenntn. der Amöben," in Zeitschr. f. wiss. Zool. Bd. xxxvi. (1882); and see Ann. & Mag. Nat. Hist. ser. 5, vol. ix. p. 106.

‡ "Studien über Amöben," *l. c.* p. 190.

§ *Loc. cit.* Wallich, in a recently published criticism of my work, justly reproaches me with this sin of omission (Ann. & Mag. Nat. Hist. ser. 5, vol. xvi. p. 215).

Observations on the Embryology of Insects and Arachnids.
By A. T. Bruce.

The work, of which a short abstract is here given, comprises observations extending over a period of nearly two years.

A more detailed and illustrated account now in course of preparation will, it is hoped, show that if these observations have not brought to light anything absolutely new they have at least thrown additional light on several important questions in insect embryology.

With insect-eggs, the opacity of which renders them unsuitable for superficial observation, the sectional method leads to the best results. This method was followed in these investigations.

The important points to be determined in insect embryology are the segmentation of the egg and the formation of the blastoderm, the origin of the embryo and embryonic membranes, the formation of the germinal layers, metameric segmentation and all connected with it, including number of appendages, nerves, ganglia, &c.

The embryology of Arachnids, or at least of spiders, shows many points of resemblance to the embryology of insects. The first trace of the spider-embryo, the so-called primitive cumulus, is not unlike the early embryo of the Orthoptera. In the head region of the advanced spider-embryo are folds which very closely resemble the amniotic folds of the insect-embryo.

The insects studied included representatives from the Lepidoptera, Coleoptera, and Orthoptera, while a few incomplete observations were made on the embryology of the Neuroptera and on the maturation of the ovum in *Musca*.

The eggs of the spiders studied probably belonged to several species.

The embryology of *Thyridopteryx ephemeræformis*, or the common bag-worm, was carefully studied. Owing to abundance of material its development was followed from the early stages of segmentation to the advanced embryonic stage.

The segmentation of the egg of *Thyridopteryx* corresponds to that of the Lepidopterous insect described by Bobretzky. It can hardly be called a centrolecithal segmentation, inasmuch as in the earliest stages cells are found, not at the surface surrounding a central yolk-mass, but lying in the yolk, whence they migrate to the surface to form the blastoderm.

In *Thyridopteryx* it appears that some of the primitive embryonic cells never reach the surface, but remain as yolk-cells, round each of which, in the later stages of embryonic development, an aggregate of yolk-spherules occurs, and thus are formed the yolk-balls or segments.

In the grasshopper, however, there is a stage in which all the undifferentiated cells are apparently at the surface, while the yolk is arranged in pyramids corresponding to the yolk-pyramids of *Artocus*.

In *Meloë*, the species of beetle studied, probably a corresponding stage occurs in which all the cells are at the surface, though there are no yolk-pyramids; consequently, in the grasshopper and in *Meloë* the yolk-cells probably arise by delamination from the cells investing the yolk.

The embryo of *Thyridopteryx* and of other insects studied arises as a thickening on the surface of the egg not unlike the primitive cumulus of spiders.

The amniotic folds arise as folds of blastoderm on all sides of the embryo, and finally meet and unite over the median line of the ventral plate; consequently the embryo (described as the ventral plate at this stage) comes to lie in the yolk covered by the inner amniotic fold or true amnion, while the outer fold or serosa remains continuous with the blastoderm. The embryonic membranes of *Mantis* and *Meloë* arise in a quite similar manner. Brandt has described a different mode of origin for the embryonic membranes of the Neuroptera and Hemiptera.

After the formation of the membranes in *Thyridopteryx*, but synchronously with the same in *Mantis* and *Meloë*, an ingrowth occurs in the middle line of the embryo, which is partly a delamination and partly an invagination. By this ingrowth is formed the inner germ-layer, which in *Thyridopteryx* certainly corresponds to both mesoderm and endoderm. The yolk-cells do not appear to take any part in the formation of the endoderm in *Thyridopteryx*. Tichomiroff, from his studies in the Lepidoptera, comes to a similar conclusion in regard to the yolk-cells.

The yolk-cells of the grasshopper also appear to take no part in the formation of the endoderm.

The amnion in *Thyridopteryx* grows dorsally more rapidly than the body-walls and its opposite folds unite dorsally before the body-walls can grow together. Consequently the amnion in this insect forms part of the dorsal surface of the body, while for a time the entire embryo is enclosed as in a sack by the outer fold of the true amnion, which does not take part in the closure of the dorsal surface.

No dorsal organ corresponding to that described by Brandt for the Neuroptera was observed in *Thyridopteryx* or in the other insects studied. The amnion of the grasshopper does not apparently form any considerable portion of the dorsal wall of the body.

The nervous system arises in all insects studied as two ectodermic strings lying on each side of the blastopore, as the median line where the inner layer arises may be called. It subsequently divides into a number of ganglia corresponding to the somites of the body. The supraœsophageal ganglion, as good longitudinal sections of the *Thyridopteryx*-embryo show, consists of two portions—a posterior portion which innervates the paired labium, and the anterior portion which supplies the antennæ with nerves. The circumœsophageal commissure is formed by a portion of the posterior division of the supraœsophageal ganglion and a portion of the mandibular division of the subœsophageal ganglion. The supraœsophageal ganglion of

Thyridopteryx has its halves united by a double commissure, one portion crossing above and the other below the œsophagus. When the nervous system has been separated from the superficial ectoderm, a median ingrowth of ectoderm occurs in *Thyridopteryx* between the nerve-cords. The cells composing this ingrowth elongate and lie close to the nerve-cords.

At this stage it appears as if this median ingrowth were uniting the cords and forming a commissure, as Hatschek claimed for the Lepidoptera studied by him. This, however, does not prove to be the case. In a subsequent stage the elongated epithelial cells undergo division and give rise to migratory cells corresponding to other migratory mesoderm cells. Cells of this nature invest the nervous system, forming its peritoneal coat, but take no part in the formation of its commissure. The three pairs of thoracic limbs are conspicuous from their size in all embryos studied.

In the grasshopper both maxillæ have two lobes outside of and at the base of the main axis of the appendage. These recall, though they are probably not homologous with, the exopodites and epipodites of the Crustacean appendage. Similar lobes have been described by Patten for the maxillæ of *Blatta*. Tracheal invaginations occur in the maxillary segments of the grasshopper. In conclusion, it remains to mention an interesting stage of the spider-embryo in which an abdominal appendage is being converted by a process of invagination into a lung-book.—*Johns Hopkins University Circulars*, no. 49, May 1886, p. 85.

Notes on the Embryology of the Gasteropods.

By J. Playfair McMurrich.

In a number of the 'Studies from the Biological Laboratory,' which will appear during the coming summer, I intend publishing a detailed and illustrated account of the results of my studies during the past winter upon the development of some marine Prosobranch Gasteropods. In the meantime, however, it is desirable that a brief abstract of some of the more important results should be presented.

The forms studied principally were *Fulgur carica* and *Fasciolaria tulipa*. The former furnished material for the earlier stages of development, while of the latter I studied only the more advanced embryos. The modes of segmentation of a few other forms, such as *Purpura floridana*, *Crepidula*, and *Eupleura caudata*, were also observed.

The first portion of my paper will deal with the ovum and the nutrition of the embryo, the non-development and employment as nutrition of the majority of the ova in each capsule of *Fasciolaria* being described and compared with other phenomena of a similar kind. In *Purpura floridana* a certain number of the ova, after segmenting regularly for some time, break down, and are employed as food by the survivors; in *Crepidula* we see the same process, but in a much less marked degree; while in *Neritina* it is carried to a greater extent, only one egg, out of a great number which, in each

capsule, undergo segmentation, coming to maturity. In *Fasciolaria* six or eight eggs develop in each capsule, the remaining ova showing not the slightest traces of segmentation, the polar globules even remaining unformed, although the ova contain a nucleus and a certain amount of protoplasm and are not simply yolk-masses.

The second portion of the forthcoming paper will deal with the segmentation of *Fulgur*. The eggs are very large, containing much yolk. A single large polar globule is formed which contains some yolk-granules. The ovum then segments into two and then four equal spherules, and from these are separated four small protoplasmic spherules, the micromeres. These then divide, after four more micromeres have been separated from the macromeres, as in the normal Gasteropod segmentation. In one point, however, *Fulgur* differs from other forms which have been studied; the number of generations of micromeres which are separated off from the macromeres is very large—apparently they continue to be separated off as long as any portion of the macromeres remains uncovered by the ectoderm. And even after the blastopore has formed and closed at the nutritive pole of the egg there can be seen, in the interior of the yolk-mass, which represents the fused macromeres, or beneath the ectoderm at the surface of the yolk-mass, cells which resemble, in certain characteristic features, the micromeres which were separated from the macromeres. These late-appearing micromeres, as they may be termed, I believe, assist in the formation of the mesoderm, this layer not being formed in its entirety from the primitive mesoderm-cell.

When the segmentation has progressed somewhat, but while the micromeres are still confined to the formative pole, three of the macromeres show elongated elevations upon their surfaces. The fourth macromere has no elevation, but gives rise to the primitive mesoderm cell. What the significance of the elevations may be I cannot imagine, but there can be no doubt that their appearance is normal, and coincides with the formation of the first mesoderm-cell; this lies below the margin of the ectoderm-cell, and corresponds exactly with the primitive mesoderm-cell of *Nassa*.

At a later stage an invagination of the ectoderm at the formative pole takes place. A deep depression is formed, which, however, later disappears and leaves no trace. It apparently corresponds with the similar invagination described by Blochmann in *Neritina* and by Sarasin in *Bithynia*, though the description given in this latter case is not very clear.

The development of the endoderm I was not successful in observing. The blastopore is formed at the formative pole of the ovum, and closes, the mouth being formed at the point of closure by an ectodermal invagination which also gives rise to the œsophagus.

The general considerations derived from the study of the segmentation of the Gasteropods will be arranged under three divisions. The first will treat of the influence of the yolk on the formation of polar globules, the second on the phylogenetic significance of segmentation, in which it will be held that the mode of segmentation

seen in *Fulgur* and so many other Gasteropods is essentially the same as that which occurs in certain Hirudinea, Gephyreans, Turbellarians, &c., and that which is to be seen in the Lamellibranchs, Annelida, and other aberrant groups can be referred to the same mode; or, in other words, that the Platyhelminths, Annelida, Mollusca, and Molluscoidea have been derived from forms which possessed a typical segmentation similar to that now to be seen in the Pulmonates and many other Gasteropods, many forms in each group, however, having departed from the original mode by reason of subsequent loss or addition of food-yolk. It will follow, as a consequence of this idea, that the regular equal segmentation, which occurs in many forms belonging to these groups, is not primitive, but has been secondarily induced by the conditions under which the eggs segment. The third division of the theoretical considerations will treat of the mesoderm.

The third and fourth portions of the paper will treat respectively of the velum and primitive excretory organs.

The fifth portion will treat of the development of the nervous system. It will be shown that the Lamellibranchs, Pteropods, and Heteropods agree in the formation of their supraœsophageal ganglion with the typical Trochophore larva of *Polygordius*. In the marine Prosobranchs, however, the supraœsophageal ganglia arise as independent local ectodermal thickenings, which have directly nothing to do with a "Scheitelplatte," and which become united with each other and with the pedal ganglia later. Between this arrangement and that of Pteropods &c. the Pulmonates offer an intermediate stage. The problematic cells which have been described by so many authors as lying in the head vesicle, and as derived from the ectoderm, and which were recognized by Wolfson to be a nervous organ in process of degeneration, no doubt represent the apical thickening from which, in the Trochozoon, the Pteropods, &c., the supraœsophageal ganglia are formed. In the Pulmonates the ganglia do not form from these problematic cells, which soon degenerate and disappear, but are formed, as in the marine Prosobranchs, from local proliferations of the ectoderm. There has been an abbreviation of the development in the case of the Pulmonates and Prosobranchs, and it is interesting to note that the latter group presents wide differences from the other Molluscan larvæ in other respects also, *e. g.* the excretory organs. The Prosobranch Veliger seems to be very highly specialized, and affords an excellent instance of larval specialization independent of the specialization of the adult.—*Johns Hopkins University Circulars*, no. 49, May 1886, p. 85.

On the Development and Minute Structure of the Pedunculated Eyes of Branchipus. By Dr. Carl Claus.

The lateral eyes of *Branchipus* possess an increased interest because, like those of the Decapoda and Stomatopoda, they are placed upon movable stalks which have only been developed in the

course of the metamorphosis, and give us some authentic information as to the morphological significance of the pedunculated eyes. In a previous memoir* I have already discussed them, and have shown that the movable pedunculated eyes represent the abstricted lateral parts of the head which have become independent. It occurred to me to trace the process of development more in detail, and in this way to ascertain the relations of the so-called eye-ganglion, on the one hand to the cerebrum, and on the other to the retina-ganglion, as also to the elements of the eye itself, and also to work out the hitherto imperfectly-known minute structure of the latter.

The foundation of the lateral eye is perceptible even in metanauplius-larvæ, the tissues of which have become clear, as a broad, pad-like, hypodermal thickening placed laterally to the frontal organ. The cell-growth is continued inwards, and here contains the material for the eye-ganglion, which is united with the brain. The pigment first appears in the lateral parts of the eyes, in which, at the same time, the first crystalline cones show themselves as small refringent bodies. The derivatives of the hypodermal cells are there already divided into a superficial layer for the formation of the crystalline cones, and a deeper layer for the nervous rods and pigment, which is continuously connected by trains of fibre-bundles with the cell-mass, which is in course of conversion into the retina- and eye-ganglia. The latter has been produced simultaneously with the foundation of the eye, as a deep-seated layer of the hypodermal swelling, which has been previously indicated by me as the matrix of the eye. This, however, not only effects the greatly increasing extension (with advancing growth) of the eye-segment, which afterwards separates as the pedunculate eye, but at the same time furnishes the material for the increase of the elements of the eye and the retina, as also of the eye-ganglion. The sagittal zone-like hypodermal cushion consequently, to some extent, represents the gemmation-zone both of the eye and of the nerve-mass occurring within the eye-peduncle, the laterally produced cells furnishing the crystalline cones and nervous rods, while the elements which advance inwardly and mesially strengthen the eye-ganglion.

In this nerve-mass in the interior of the eye-peduncle, distinguished as the eye-ganglion, we distinguish two portions, both of which proceed, by continuous growth, from the band-like gemmation-zone, namely, a distal retinal part turned towards the base of the hemisphere of the eye, and a proximal segment united with the cerebrum, the eye-ganglion *sensu strictiori*.

The latter contains a central mass of parenchyma and a superficial coat of ganglion-cells, which appears to be considerably thickened on the anterior surface, and gradually disappears towards the posterior concavely incurvate side.

The fibre-trains of the parenchymatous layer, radiating from the cerebrum, traverse the eye-ganglion transversely in a straight course,

* 'Zur Kenntniss des Baues und der Entwickelung von *Apus cancriformis* und *Branchipus stagnalis*' (Göttingen, 1873).

to enter the parenchymatous layer of the retinal segment through a connective boundary-layer filled with large nuclei; another portion of nerve-fibres originates, however, from the coating of ganglion-cells itself, and crosses the first set of fibre-trains in an oblique direction. In comparison with the eye-ganglion of the Malacostraca, the ganglionic cortex and intercrossing of fibres are very simple, and the parenchymatous mass is not yet, as in them, divided into two or three parenchymatous layers between which the fibre-trains form new internal crossings.

The fibre-crossing in the eye of *Branchipus* therefore only represents the crossing distinguished by Berger as "external" in the eye of the higher Crustacea.

This considerable simplification, which we cannot assume to be due to any secondary reduction, justifies us in starting from the Phyllopod-eye in estimating the two main divisions of the ganglionic apparatus. The first, or proximal part, which, in the eye of the higher Arthropoda undergoes a further division, is the cerebral portion of the eye-ganglion; the distal portion, which is bent almost at right angles to this, and which retains essentially the same structure throughout, is its retinal part, or the retinal ganglion.

This interpretation, already set up by Berger, which at the same time recognizes in the ganglion-cell coat of the proximal eye-ganglion a centre of projection of the second order, is perfectly in accordance with the simplified structural conditions of the eye of *Branchipus*, in opposition to the interpretation of other naturalists who, in the compound eye of the Decapoda and Insecta, do not separate the retinal ganglion distinctly from the eye-ganglion, and regard it as equivalent to the preceding division, but either treat the whole as the retina, or, going to the opposite extreme, refer it to the cerebrum, and regard the nerve-bundles passing to the rods only as the visual nerve-fibres.

The structure of the eye in *Branchipus* is also simpler than in any other pedunculate eye. Above all we have to notice the absence of special pigment cells in the vicinity of the nerve-rods, as also of the crystalline cones. The pigment is deposited rather in the deeper hypodermal cells employed as parts of the sensitive apparatus, in the elements of the nerve-rods around the rhabdoma, and peripherally in the nerve-fibres of the so-called nerve-bundle layer. The rapid movement of the blood takes place in the interstices of the latter, and also in front of the basilar layer in spaces between the attenuated ends of the crystalline bodies. There is no facettation of the cornea, but, as in the eye of *Phronima* (and this is the case also in that of *Apus*), there is a special layer of hypodermal cells above the crystalline bodies. We shall have to regard the presence of this layer of cells as well as the absence of corneal facets and special pigment-cells, and the presence of interstices for the circulation of the blood in the nerve-bundle layer and the layer of crystalline cones, as representing the original form of the Arthropod compound eye, and the appearance of corneal facets by the deficiency of the superficial hypodermal layer as secondary.—*Anzeiger der k. Akad. Wiss. Wien,* March 18, 1886, p. 60.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 104. AUGUST 1886.

IX.—*Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland).*—No. V. *On the Paternal Instincts of* Cyclopterus lumpus, *L.* By Prof. M'INTOSH, M.D., LL.D., F.R.S., &c.

THE care which certain male Teleosteans take of the ova is well known, while Dr. Günther mentions only two cases (viz. *Aspredo* and *Solenostoma*) in which females do so. In this country the males of the river bullhead, the lumpsucker, and the marine and freshwater *Gastrostei* are familiar instances, an interesting account of *Gastrosteus spinachia*, by Mr. E. E. Prince, indeed, having but lately appeared in this journal *.

Most authors who have treated of *Cyclopterus* have observed this feature in the male †; but the interpretations placed on it have been varied, some supposing that the mere fact of the male being in the neighbourhood at deposition sufficed to account for its subsequent appearance near the eggs, while others, after Fabricius, bestowed considerable attention on the description of the instinct. In regard to the remarks of Fabricius, however, it is doubtful if the wolf-fish would be much inconvenienced by the attacks of the lumpsucker.

* Ann. & Mag. Nat. Hist. Dec. 1885, pp. 487 *et seq.*

† It is sufficient, under ordinary circumstances, to try to push them off guard with a stick to bring out this clearly.

Even in its larval condition the young *Anarrhichas* makes an easy prey of the young *Cyclopteri*.

About the middle of May a male *Cyclopterus* was found a short distance from low-water mark in a broad runlet with his head close to a mass of ova placed on the seaward edge of a stone. The stream of sea-water was so shallow as to leave the stone partly exposed, and was quite insufficient to float the fish, which was $11\frac{1}{2}$ inches in length. Accordingly, for a considerable period twice daily the devoted male had to lie in the runlet on his side, a portion of his body, including the upper opercular region (in this position) being above water. From the situation of the ova on the stone just described the current of the runlet flowed into the mouth of the fish, which, in the warm sun of June, must have been less comfortable than under ordinary circumstances, a fact which is at variance with the "accidental" theory formerly mentioned. The cool and ever-changing stream, however, sufficed for aeration, the movements of the hyoidean apparatus and the mandible, as well as the direction of the stream, causing a current over the upper as well as the lower branchiæ. Thus, although the action of the branchial apparatus and the heart was occasionally a little hurried in the warm sun, no serious effect ensued. For five or six weeks this faithful male was found at low water in this position, sometimes on one side and sometimes on the other. In order to test it still further Mr. Scharff removed the fish a couple of yards from the eggs and placed it on a stone. It wriggled actively into the water, at once rushed to the ova, and assumed its former position with the snout almost touching the eggs. The same ensued when it was placed in the runlet at a somewhat greater distance. The solicitude of the males for the ova which they have under charge was further illustrated by the occurrence early in May of a heavy sea, which swept masses of the ova from their positions all along the rocks. As soon as the sea became calm numerous anxious males, like "pilgrims," were seen by the laboratory attendant (who had been familiar with the sites) seeking for their lost charges. Many of these masses of eggs were found on the beach, so that the statement is probable.

As soon as the eggs were hatched the male was released, and the young spread themselves over the rock-pools in the neighbourhood in hundreds. It is unlikely, however, that they are dispersed by specially adhering to the body of the male, though they quickly cling to anything and even to each other. Their home appears for some time to be the littoral region and especially the rock-pools, and they are occasionally

found in considerable numbers in August, when the larger examples caught with a hand-net measured about $\frac{7}{8}$ inch. They adhere to the blades of the tangles and other seaweeds, and in the mazes of these find that safety (from the ready application of their suckers) which would be denied them in the open sea. When caught in the tow-net inshore it is generally along with floating littoral seaweeds with which they have migrated.

Besides the various shades of green which characterize the young *Cyclopteri* some are beautifully variegated with touches of brown, while pale bands or streaks of silver, often symmetrically arranged, give them a striking appearance. Others again are dotted over with black points. On emerging from the eggs they swim actively through the water, the pectorals being kept in rapid vibration, and they soon become predaceous, attacking as they grow older the smaller forms of their own species as well as minute Mysidæ and other prey. The young examples caught in the rock-pools had fed on the abundant larval crustaceans, such as larval Cirripedes and Copepods. The larval fin speedily becomes differentiated into the two dorsals and the anal. The first dorsal resembles at the tenth or twelfth day the other fins, that is it is membranous, as Mr. Thompson, Prof. Alex. Agassiz*, and other observers have noted, and has six slender spines. The metamorphosis of this fin occurs subsequently.

The period of spawning at St. Andrews ranges from February to May, and this year it was especially late, probably from the severe and long-continued winter. The young captured during the first ten days of July therefore showed considerable variation in size. A feature of interest in regard to the fisheries is the fact that food-fishes and others are extremely fond of the ova of *Cyclopterus*. Thus at the end of April about one hundred fine codling were caught by the liners in St. Andrews Bay, off the rocks at Boarhills, and the stomachs of these were distended with the ova of the lumpsucker. Even such small fishes as Yarrell's blenny (*Carelophus Ascanii*) took the same food. Whether these attacks from without cause the hollows in the masses of ova (which resemble holes that have been scooped out) is unknown, but these are very common. Some perforations in the masses may have been due to their position over the apertures of *Pholas crispata*; but the former hollows were produced by other causes.

The *Cyclopteri* form no *nests*, the ova being deposited chiefly on the sides of rocks and stones. They have been very abundant this season both amongst the rocks and in the

* Proc. Amer. Acad. of Arts and Sci. vol. xvii. p. 286, pl. iv.

salmon-nets (in the latter especially in easterly gales, which rendered the water muddy); in one case, indeed, the net could not be pulled up off the east rocks, from the great weight of the captured lumpsuckers (estimated at several tons), and it was ruptured. They are only used along with fish-offal for manure.

Pennant's observation with regard to the tenacity with which an adult clings by its sucker to a pail full of water has been found to be quite accurate. The whole can be lifted by seizing the fish, and a greater weight than 43 pounds (which was that of pail and water) could readily be raised in this manner.

X.—*On the Presence of Oleaginous Spheres in the Yolk of Teleostean Ova.* By EDWARD E. PRINCE, St. Andrews Marine Laboratory.

OF the 9000 or 10,000 species of osseous fishes known to zoologists the eggs of not more than 80 have been obtained and determined. This comparatively small number indeed includes several species whose ova have been discovered only within the last twelve months by Prof. M'Intosh at the St. Andrews Marine Laboratory, and are therefore new to science. Quite a large proportion of these eggs are characterized by the presence in the yolk of large refringent masses, the so-called oil-globules. These structures have long been familiar to embryologists, and they constitute a prominent feature in those Salmonoids whose development is more completely known than that of any other group of Teleosteans. Yet the significance and function of these bodies seems to be little understood, or, more truly, seems to be wholly misunderstood. Of course all fish-ova have oily elements in their protoplasm, some cholesterin being constantly present, with other fatty matters, in addition to myosin and the usual derivatives of albumin; but these elements, when they can be detected optically, are microscopic, and, being distributed as minute vesicles all over the vitellus, strikingly differ from the large globules here considered. Not only in size, but in colour, situation, and relation to the rest of the ovum, and almost certainly also in chemical composition, these large spheres are distinguished from the microscopic fatty particles present in all ova. So well-marked and characteristic are

these spheres that the species to which an ovum belongs may often be determined at a glance by their aid.

Struck by their diagnostic significance, Agassiz and Whitman divided pelagic eggs into two great divisions, those which are provided with one or more oil-globules and those which are not so distinguished *. Such a division has, however, little value, as the occurrence of these large globules is apparently most erratic—the ova of closely-allied species exhibiting the utmost diversity in this respect. Indeed the American observers themselves describe an ovum of a Pleuronectid (*Pseudorhombus oblongus*) showing a large oily sphere, a structure not present in the egg of any other species of flounder known to zoology. The ova of the Gadoids, too, are marked by the absence of such structures; yet a remarkable exception has been recently found at St. Andrews, viz. the hitherto undescribed pelagic egg of the ling (*Molva vulgaris*), which exhibits a single oleaginous sphere of a pale green tint. Additional exceptions are furnished by the closely-allied freshwater species, *Lota vulgaris* (the oil-globule in which, as described by Van Bambeke †, is almost precisely like that in the egg of the ling), as well as the eggs of the American *Brosmius* ‡ and *Motella mustela* §, while the ova of all other Gadoids at present known lack this marked feature, no large globule being present in the case of the cod, haddock, whiting, bib, &c. Again, we find amongst freshwater forms that the ova of the salmon, trout, and grayling have large rufous-tinted spheres enveloped in the deutoplasm or yolk, whereas in other forms which inhabit the same waters and deposit their ova in similar situations, such as the pike ‖, tench, roach ¶, &c., no such globules are present. A classification of ova founded on the presence or absence of these spheres presents a strange medley—the two lists bringing together widely separated species and placing side by side fishes with pelagic and demersal ova, and most diverse freshwater and marine forms. An undoubted specific value belongs to these spheres; but no generic or wider diagnostic significance can be attributed to them. Certainly the interpretations which the presence of these globules has hitherto received are not only unsatisfactory, they are undoubtedly

* 'Studies from Newport Marine Laboratory.—XVI. Dev. Oss. Fishes,' p. 2 (1885).

† "Recherches sur l'embryologie des poissons osseux," Mém. Cour. de l'Acad. Roy. de Belgique, tome xl. p. 5.

‡ U. S. Fish. Comm. Rep. 1882, p. 467.

§ G. Brook, Journ. Linn. Soc., Zool. vol. xviii. p. 298.

‖ E. B. Truman, Month. Microsc. Journ. vol. ii. 1869, p. 188.

¶ Van Bambeke, *loc. cit.* pp. 2 and 13.

erroneous. Ryder attributes the buoyancy of certain pelagic ova to these structures, and, strangely enough, later observers have put forward the same view, notwithstanding the fact that the most familiar of Teleostean eggs, viz. those of the Salmonoids, possess such spheres in abundance, and yet are wholly destitute of the power of floating. In a list of twenty-two Teleostean ova without large globules, seventeen (or about 75 per cent.) are pelagic. On the other hand, about twenty-four species of Teleosteans are known to possess these globules, and fifteen of these are pelagic, a proportion not far removed from that furnished by the list just named. In other words, the pelagic eggs without large globules are about the same in number as those possessed of globules, so far as researches at present show; and to explain the buoyancy of floating eggs by the presence of these structures is a manifest fallacy *. Moreover, large globules are present not only in demersal eggs which are littoral, *i. e.* deposited near shore, such as those of various species of *Cottus*, *Liparis*, *Gastrosteus*, &c., but ova brought up from some depth show their presence also, an example of great interest being the large non-floating egg of *Anarrhichas lupus*, which has been reared and studied at St. Andrews for the first time. From an examination of the ovaries of the catfish in February 1884 Prof. M'Intosh concluded that the ova were deposited on the bottom of the sea †, and they have proved to be so; yet they exhibit a single refringent globule of large size of precisely the same appearance as the globules in the familiar ovum of *Cyclopterus*, which is deposited between tide-marks. It is plain that while these globules are of less specific gravity than the remaining contents of the egg, as is shown by the fact that they always seek the upper side, whereas the germinal area descends to the lower side of the ovum, yet they do not produce buoyancy; nay, in demersal eggs these vesicles are even more abundant than in pelagic or floating eggs. Their function is plainly not hydrostatic. A second theory has been put forward by Van Bambeke, viz. that the globules have a nutritive function; and in speaking of the central globule in the egg of the burbot (*Lota vulgaris*) he says:—" Il n'est pas douteux que la gouttelette réfringente centrale remplace ici les éléments nutritifs qui, chez la tanche, vont s'accumuler sous le germe " ‡. He adds this important

* *Vide* Prof. M'Intosh's observations, 'Nature,' vol. xxxi. p. 555; Ann. & Mag. Nat. Hist. 1885, vol. xv. p. 435 &c.

† Ann. & Mag. Nat. Hist. June 1885, p. 432, and 'Nature,' June 24, 1886.

‡ *Op. cit.* p. 6.

statement:—" Sur quelques œufs, j'ai vu une communication s'établir entre le germe et la gouttelette du globe vitellin, comme si le germe allait puiser à cette source de nutrition ; " and in the figure which he gives (pl. i. fig. 14) it is difficult to explain the existence of the column of protoplasm connecting the globule and the germ, except as indicating a trophic function, unless the ovum were abnormal, which it most probably was. Unfortunately the ovum in question was not fertilized, and the subsequent fate of the globule was not ascertained. In studying the complete development of the ling, gurnard, catfish, and other forms at St. Andrews unusually favourable opportunities were afforded for tracing the destination of the globular bodies, and the evidence gained strongly militates against Van Bambeke's theory that the germinal disc is nourished by them. Not only do they show no decrease in size and persist in the pendulous yolk for some time after the embryo is liberated, but the actual position of the globules in the early ovum is unfavourable to Van Bambeke's view.

As already stated, the normal position of the globules is constant, viz. in the upper segment of the ovum, at the vegetal pole, and they therefore occupy the region most distant from the germinal disc. In a small number of eggs, however, this is not the case, and a remarkable example described by Agassiz and Whitman * is the ovum of *Cottus grœnlandicus*, in which from ten to forty globules are more or less evenly scattered over the surface of the yolk. This ovum, strange to say, is pelagic; whereas all other Cottoids, so far as known, have demersal eggs, and all alike are abundantly supplied with large oil-globules. A similar condition occurs in the ovum of *Trachinus vipera*—in which the oil-globules according to G. Brook are " scattered over the upper hemisphere of the yolk, and lie between it and the vitelline membrane " or capsule †. The large globule in *Lota vulgaris* is central, but this position is very unusual, and it is perhaps permissible to suggest that Van Bambeke may have mistaken the apparent for the real position of this body. The globule always rises to the upper side of the egg, and when the latter is on the stage of the microscope, unless by very careful manipulation, the actual position of the vesicle cannot be made out. Viewed under the usual microscopic conditions, the oil-globule in *Motella*, *Trigla*, *Molva*, &c. appears to be central, when in reality it is not so. The oil-globule in truth occupies different

* 'Studies from Newport Mar. Lab.—XVI. Develop. Oss. Fishes,' p. 7.
† G. Brook, Journ. Linn. Soc., Zoology, vol. xviii. p. 274.

situations in different species, occurring within the yolk mass or outside it, in the perivitelline space, or rather in a fossa or pocket indenting the surface of the yolk. Examples of the latter condition are afforded by the Gadoid ovum studied by Häckel, and by *Motella mustela*, *Lophius piscatorius*, *Molva vulgaris*, and other forms. Instead of being seated, however, in a depression or pocket lined by the cortical protoplasm of the vitellus, the large vesicles may lie within this protoplasmic layer, or rather in the albuminoid matrix of the yolk.

In *Gastrosteus*, *Liparis*, *Cottus*, *Cyclopterus*, and other demersal eggs the globules, which are very numerous, and collect together in a large group at the vegetal pole, are thus surrounded by yolk substance, which, however, has sufficient fluidity to permit free movement, and the mass of vesicles may be made to traverse all parts of the inner surface of the yolk cortex, by turning the egg about in various directions. An interesting American pelagic egg, *Temnodon saltator*, which exhibits a single globule only, is in like manner imbedded, and has apparently shifted to a position immediately beneath the germinal disc in the figures given by Agassiz and Whitman*. Professor M'Intosh has proved that the globule in *Trigla gurnardus* does not occupy a position in the perivitelline space, as some observers have stated, but freely moves through the deutoplasmic mass.

Though thus capable of transference from one region of the yolk to another, the normal position always is distal to the animal pole, and to this upper (vegetal) segment the globules invariably return when the rotated egg comes to rest. These vesicles in some ova seem to have less freedom of movement, and appear to be imprisoned by the surrounding matrix.

Thus E. Van Beneden speaks as follows of the ovum examined by him :—"The animal pole was always directed downwards, the vegetative pole upwards. I ascertained that in my eggs the position of the oil-drop was quite constant. It is always placed eccentrically, and invariably occupies a position in the vegetative hemisphere, but is immersed in the albuminoid substance which surrounds it on all sides. I have in vain endeavoured to explain to myself this fact by some peculiarity of structure in the protoplasm. I entirely failed to discover any trace of filaments connecting the oil-drop either with the surface of the vitellus, or with the germinal disc"†. It may be noted that the pseudopodial threads here referred to have been seen in *Gastrosteus spinachia* ‡, *G. aculeatus*, *G. pun-*

* 'Studies from Newport Mar. Lab.—XVI.,' plate iv. figs. 1 and 2.
† E. Van Beneden, Quart. Journ. Micr. Sci. vol. xviii. p. 44.
‡ Ann. & Mag. Nat. Hist. 1885, vol. xvi. p. 492.

*gitius**, *Tinca vulgaris* †, &c. In the salmon the globules are held in position by the coherent granular cortex of the vitellus; they are not, however, merely free vesicles defined by the surrounding matrix, but, as His notes, "sind je von einer Hülle protoplasmatischer Substanz umgeben" ‡. This enveloping coat is well seen in the gurnard, and it increases in thickness as development proceeds, being very uneven and imprisoning many small colourless vesicles, precisely as His figures in the case of the ovum of the salmon &c. §

Van Beneden has omitted to show any definite layer, and Lereboullet does not indicate it in the ovum of *Perca* ||, though it is improbable that in either case the globule is destitute of the limiting layer present in other forms. His figures, in the plates just referred to, connected and isolated globules in the eggs of the salmon, trout, and grayling, and discusses fully the character of the coherent granular protoplasm which clothes them ¶.

The precise chemical nature of these large globules is still involved in some uncertainty. That they are of an oleaginous nature cannot be doubted, though it is scarcely accurate with E. Van Beneden to describe a sphere of this kind as "a drop of oil or fat," for the investigations of Professors His and Miescher show its composition to be that of no known fat **. If an ovum of the gurnard, for example, be treated with osmic acid, the minute vesicles scattered over the vitellus stain very rapidly and deeply, whereas the large globule is coloured slowly and more faintly—proving the former to be more emphatically oleaginous than the latter. The large globules exhibit a more or less brilliant translucency; they float in water and are soluble by ether, though, according to Miescher they reveal no more than a trace of phosphorus.

Their composition, while closely allied, is not identical with that of any of the fats, and they may best be associated with those remarkable derivatives of albumin, the lecithin-group. To that group His, indeed, refers them, though he confesses that strictly their nature is undecided. The association of these spheres with lecithin is a matter of extreme interest, for lecithin is a substance always present in cells of ova under

* Phil. Trans. vol. clvii. (1867).

† Van Bambeke, *op. cit.* p. 2, and plate i. fig. 2.

‡ His, Untersuch. über das Ei und die Entwickl. bei Knochenfischen, 1873, p. 7.

§ *Op. cit.* Taf. i. figs. 1, 2, 4, 5, 11, and 12, and Taf. iv. fig. 38.

|| Lereboullet, Mém. des. sav. étrang. t. xvii. p. 460, and plate iii. figs. 3, 7, and 8.

¶ *Op. cit.* pp. 6, 7.

** *Ibid.* p. 7.

developmental conditions. May not this fact throw light upon the significance of these globules? We have seen that their presence cannot be explained by resorting to a hydrostatic function, and there are great difficulties in the way of the nutritive theory. Is it not possible that they may have some ancestral significance? The distinctive coloration they exhibit is an interesting point, though it can give no aid in the matter. Nevertheless it is remarkable that the orange tint of these spheres, in the ovum of the Salmonoids, is precisely that which distinguishes the oily matter in the muscular tissue of the adult fish. The flesh of the common mackerel, the Spanish mackerel, and the gurnard, not to mention others, is regarded as somewhat oily, and the ovum of each of these fishes exhibits a large globule. The oleaginous matter in the flesh of the last-named fish is of the same tint as that of the sphere in the ovum. The globule in the ling is of a pale green hue; and in the allied form, the burbot, Van Bambeke describes it as "très-réfringente, d'une teinte jaunâtre"*. The globules in the fifteen-spined stickleback, and in certain Cottoids, are of an amber colour, but in many forms (e. g. *Cyclopterus*, *Cottus*, *Motella*, &c.) they are almost perfectly colourless. These features are of minor importance, however, compared with the fact that in the ova of so many species of Teleosteans large spheres of a substance closely connected with the lecithin-group should occur. Lecithin is peculiarly active in all embryonic development, and the possibility is suggested that, though the matter constituting these globules may be disproportionately large as compared with the volume of the vitelline mass, yet it was not always so. That the yolk-matter of the Teleostean ovum was once greater in bulk than it is now, is (in accordance with Balfour's view †) an accepted conclusion. If as the vitelline mass diminished the lecithin or similar fluid did not decrease in the same degree, globules would be formed precisely as we find them in so many Teleostean eggs. The amount is more than the necessities of development appear to require; and thus we find that during the growth of the blastoderm, and during the early stages of the embryo, these superfluous elements are not utilized and do not appreciably decrease in volume. They are enveloped by the blastoderm, and in the liberated embryo generally occupy a posterior position in the diminishing yolk, on the ventral surface of the young fish. Finally they disappear in the last stages of larval life by absorption; but up to that point retain the character of redundant and superfluous elements in the deutoplasmic mass.

* *Loc. cit.* p. 5.

† Journ. Anat. and Phys. vol. x. p. 551.

XI.—*Description of a new Gecko of the Genus* Nephrurus. By G. A. Boulenger.

Nephrurus platyurus, sp. n.

Head large, oviform, very distinct from neck; snout as long as the diameter of the orbit, or the distance between the latter and the ear; loreal region and forehead concave; ear-opening a vertical slit, measuring two fifths the diameter of the orbit. Body and limbs as in *N. asper*, but the palmar pads far less distinct. Vertex and occiput with juxtaposed rough subconical tubercles of subequal size; only four of these tubercles across the middle of the interorbital space (ten tubercles or granules across the same region in *N. asper*); snout with smaller keeled granules; loreal concavity minutely granulate; temples finely granulate, with equidistant, round, rough tubercles; upper eyelid without conical tubercles; rostral as broad as mental (nearly twice as broad as mental in *N. asper*); seventeen upper and about as many lower labials; no chin-shields. Body and limbs finely and uniformly granulate inferiorly, more coarsely above, where the granules are intermixed with numerous isolated, conical tubercles; gular region granulate, with slightly enlarged tubercles on the sides. Tail half as long as head and body, depressed, as broad as the body, attenuated at the end, which bears a globular knob; the upper surface of the dilated portion of the tail with transverse series of conical spinose tubercles; eighteen transverse grooves are distinct on the upper and lateral surfaces of the tail; lower surface uniformly and finely granulate. Pale brownish above, with three angular brown cross bars on the neck and shoulders, and two similar ones on the sacrum, separated by narrower whitish interspaces; border of the eye, and a spot in front of and another below the same, whitish; a brown horizontal spot in front of the eye, below the white spot; some of the enlarged dorsal and caudal tubercles whitish; lower surfaces whitish.

	millim.
Total length	87
Head	20
Width of head	15
Body	39
Fore limb	25
Hind limb	30
Tail	28

A male specimen, from Adelaide, presented to the Natural History Museum by the Rev. T. E. Lea.

XII.—*Report on the Testaceous Mollusca obtained during a Dredging-excursion in the Gulf of Suez in the Months of February and March* 1869. By ROBERT MACANDREW.—*Republished, with Additions and Corrections, by* ALFRED HANDS COOKE, M.A., Curator in Zoology, Museum of Zoology and Comparative Anatomy, Cambridge.—Part V.

[Continued from vol. xvii. p. 142.]

Shell.	Station.	Distribution.	Remarks.
ARCADÆ.			
Arca navicularis, *Brug.* ..	Two specimens; 5 fath.	China. [Solomon Islands, Torres Straits, Queensland, Cape York.]	
—— arabica, *Forsk.*......	Frequent, shore to 5 fath.	Red Sea. [Bourbon, Natal.]	This common Suez species appears to me rightly named; compare Philippi, Abbild. vol. iii. *Arca*, tab. iv. f. 2. That figure, although sufficient for identification, is a bad one, and does not bring out the point of marked difference between this and all other *Arcas* of this type from eastern seas, viz. the very obtuse angle (Phil. represents it as a curve) formed by the upper end of the posterior margin; hence the whole posterior margin is not so much truncated as produced into a sharp point at its lower end. It follows that Issel (Mar Rosso, p. 90) was mistaken in regarding this shell as *retusa*, Lam., and Vaillant (Journ. de Conch. 1865, p. 115) equally so in regarding it as *imbricata*, Brug. Philippi pleads for the separation of his *A. Kraussii* (*cf.* Abbild. vol. iii. *Arca*, tab. v. figs. 8, 9, 10; Krauss, Südafr. Moll. p. 14, tab. i. fig. 13); but a large series of *arabica*

			enables me to identify them with some certainty. His figures of *Kraussii* are exact representations of young specimens of *arabica* now before me.
—— decussata, *Sow.*	Not rare; 5 fath.	Philippines, Australia.	
—— parva, *Reeve*........	Rare; 5 fath.	Pacific Ocean, Persian Gulf.	One of the three specimens is *setigera*.
—— setigera, *Reeve* [=lacerata, *L.*].	Frequent, low water.	Zanzibar.	The species appears quite inseparable from *lacerata*, L.; Reeve indeed admits that they "approach very closely." It seems to me that *setigera* is the form from the eastern coasts of the Indian Ocean and the Red Sea, a form whose degeneration from the type in size and in quality of epidermis becomes marked, as being some distance removed from what may be termed its centre of distribution. It may be added that the teeth present, in their curved arrangement, exactly the same approach to the hinge of *Pectunculus* as Reeve notes with regard to *lacerata*.
—— striata, *Reeve* [=lactea, *L.*].	Frequent, low water, under stones.	[British Islands (S. of Oban) to Canaries, Mediterranean, Red Sea, Philippines, Bermuda (?), Natal.]	Quite undistinguishable from our common *lactea*, L. Issel, who does not mention *striata*, gives the Suez species as *lactea*, L., var. *erythræa*. To judge from specimens thus labelled, given to MacAndrew by Issel himself, and also from the comparison of the series (fourteen) before me with numbers of English and Mediterranean specimens, there is not even the difference of a variety. *Zebuensis*, Reeve (P. Z. S. 1844, p. 125), is the same shell. Weinkauff (Conch. des Mittelm. vol. i. p. 197) quotes the Red Sea as a habitat for *lactea* on the authority of Philippi.
—— trapezina, *Lam.*	One specimen.	Philippines.	Certainly not *trapezina*, which is strongly granulated; but I cannot refer it to any known species.

Shell.	Station.	Distribution.	Remarks.
Arca plicata, *Chemn.*	Not unfrequent.	Red Sea. [E. Indies, Japan.]	Rightly identified from Mart. & Chemn. (vol. xi. p. 244, tab. 204, pl. 2008), and there given from the Red Sea. There are several *Arcas* of this type. Lischke (Japan. Meeres-Conch. 1871, ii. 141 ff) unites *gradata*, Brod., *squamosa*, Lam., *domingensis*, Lam., and *divaricata*, Sow. This appears to be an error. There seem to be three distinct forms, agreeing in general form and sculpture, but amply distinguished from one another in small points and in their distribution. *Gradata* is the W.-American form; area behind the keel large, nodules pointed at each end, interstices oblong. *Domingensis*+ *squamosa* is the W.-Indian form; ribs, exclusive of those behind the keel, about 50, nodules not round, but long oval, very close together, very deeply cut, and well defined. *Divaricata*, Sow. (=*plicata*, Chemn.), is the E.-Indian form; posterior ribs frilled, number 26–30, a much longer stouter shell, ventral margin often broadened to distortion, nodules round, interstices square.
—— pygmæa, *H. Ad.* [=clathrata, *Reeve*, juv.].	....	....	This species, described in P. Z. S. 1872, p. 11, pl. iii. fig. 15, is simply the young shell of *clathrata*, Reeve (not Lam.), P. Z. S. 1844,=*rotundicostata*, Reeve, *ibid.* It is extraordinary that Mr. Adams should have committed the blunder of making a new species out of an old one whose type was in the Brit. Mus.
—— Hankeyana, *Reeve* [scapha, *Chemn.*].	Shore, rare.	Mozambique. [Mauritius, Port Essington.]	A misidentification; there is no sign of the four separated ridges which compose the

			ribs. The shell (there is only one) is nothing but the common *scapha*, Chemn.
—— transversa, *H. Ad.* [transversalis = scapha, *Chemn.*, juv.].	....	....	*Transversa* is a mere misprint for *transversalis*. The "species," described in P. Z. S. 1872, p. 11, pl. iii. fig. 16, is nothing but a young specimen of *scapha*, Chemn., as a moment's consideration would have shown to any one not intent on species-making.
—— rotundicostata, *Reeve* [=clathrata, *Reeve*].	Shore, rare.	[Amboyna, Torres Straits.]	See remarks on *pygmæa* above.
Axinæa arabica, *H. Ad.* . .	8–10 fath., frequent.	....	A good species; it seems strange that one so common should not have been discovered before.
—— livida, *Sow.*			
Pectunculus pectiniformis, *Lam.*	Shore, frequent.	Philippines, *Persian Gulf.	
Limopsis multistriata, *Forsk.*	5–20 fath., mud; abundant.	[Ceylon, Singapore.]	A fine series of twenty-three in every stage of growth.
—— cancellata, *Reeve* [=multistriata, *Forsk.*, juv.].	Three specimens.	Singapore.	Although Reeve states (Conch. Icon. vol. i. *Pectunculus*, no. 39) that "there is no possibility of confounding this with any other species," yet I have no hesitation in identifying it with *multistriata*, Forsk. The type (in Brit. Mus.) is a young specimen of the latter, from which the epidermis has been entirely removed. Mr. E. A. Smith (Rep. 'Challenger,' Lamellibr. p. 256), who does not seem to know of *multistriata*, adds *Woodwardi*, A. Ad., and *Philippii*, A. Ad. (P. Z. S. 1862, pp. 230, 231), to the synonymy of *cancellata*.
Nucula inconspicua, *H. Ad.*	30–40 fath.; numerous valves, one living.	*Persian Gulf.	

* Species and localities thus labelled are added to the original list in MacAndrew's own handwriting.

Shell.	Station.	Distribution.	Remarks.
CHAMIDÆ.			
Chama cornucopia, *Reeve*	Frequent; reefs.		
—— foliacea, *Quoy*? [cornucopia, *Reeve*].	Rare; reefs.	Philippines.	
—— reflexa, *Reeve* [=cornucopia, *Reeve*].	Common; shallow water.	N. Australia.	
—— Rüppellii, *Reeve* [=cornucopia, *Reeve*].	Common; shallow water.	Red Sea.	Howevermuch these four so-called "species" may differ at first sight, yet careful examination convinces me that the specimens (and they are many) all belong to one species, and to one only. It would be impossible here to enter into a discussion of the facts in the case of a genus notoriously so variable as *Chama*, when Reeve has made fifty-five species out of material probably better represented by ten. Whether even the four species here supposed to be represented are ultimately synonymous I do not discuss, being merely occupied with the species before me. But any one who cares to examine the types in the Brit. Mus. may note the exceeding similarity not only of these, but also of *nivalis*, Reeve, *brassica*, Reeve, and *rubea*, Reeve.
TRIDACNIDÆ.			
Tridacna elongata, *Lam.*	4 fath.; reefs.	Philippines.	
—— rudis, *Reeve*	4 fath.; reefs.	Philippines.	
—— *gigas, *L.*	One specimen.	....	In the present unsatisfactory state of the genus I am quite unable to do more than

			record my opinion that all the specimens of *Tridacna* in the collection (only four) belong to one species, probably to *gigas*, L. I since see that Mr. E. A. Smith says ('Challenger' Report, Lamellibr. p. 171), "I should not be surprised if *Tridacna squamosa* or *Tr. rudis* should prove to be the early stages of *gigas*."
CARDIIDÆ.			
Cardium maculosum, *Wood* [arenicolum, *Reeve*].	Rare.	West Columbia.	There is some confusion here. The shells (a good series) are *maculosum*, Sow. (non Wood, a tropical W.-American shell), apparently renamed *arenicolum* by Reeve (Conch. Ic. vol. ii. *Cardium*, no. 78).
—— biradiatum, *Brug.* ..	....	[Persian Gulf, Philippines.]	
—— magnum, *Chemn.* ..	Valves; on shore.	Ceylon, Madagascar, &c.	Better known as *rugosum*, Lam., *magnum*, Born (non Chemn.), having priority.
—— arabicum, *Issel.*			
—— parvum, *H. Ad.*	....	....	Not in the collection.
—— sueziense, *Issel*	Frequent.	Persian Gulf. [Fiji.]	
—— pectinatum, *L.*	A fragment.		
—— papyraceum, *Chemn.* [tenuicostatum, *Lam.*, juv.].	Not common.	Philippines.	A large number of immature specimens. They are not *papyraceum*, differing entirely in the character of the ribs and having no anterior granulations. They are the young form of *tenuicostatum*, Lam., which is nearly circular, but becomes more ventricose and shouldered as it grows older.
—— tenuicostatum, *Lam.*	Not common.	New Holland.	
—— papyraceum, *Chemn.* [biradiatum, *Brug.*, juv.].	....	....	Another card, but quite different from the others labelled *papyraceum*, and not right either. These are the young of *biradiatum*, Brug.

Shell.	Station.	Distribution.	Remarks.
Cardium carditæforme, *Reeve*	Rare.	[Andamans.]	
—— nivale, *Reeve*	Not common.	Philippines.	
—— fornicatum, *Sow.*	5–20 fath.; rare.	....	Not in the collection.
—— auricula, *Forsk.*	Not common.	[Bourbon.]	
—— subretusum, *Sow.*	Rare.		
LUCINIDÆ.			
Lucina dentifera, *Jonas*	Rare; 5-20 fath.	Red Sea.	A fine series of eleven specimens in every stage of growth.
—— Fischeriana, *Issel*	Common on shore at Suez.	*Persian Gulf.	This is a good species and very distinct. Issel calls the margins "*simplices*;" in the specimens before me they are slightly but distinctly dentated.
—— Semperiana, *Issel*	Frequent in 5–10 fath.	*Persian Gulf.	
—— elegans, *H. Ad.*			
—— concinna, *H. Ad.*			
—— Fieldingi, *H. Ad.*	....	....	All these three are good species.
—— quadrimaculata, *d'Orb.* [quadrisulcata, *d'Orb.*].	....	[Ceylon, Japan, Australia, New Zealand, West Indies, W. Columbia, Panama.]	A misprint for *quadrisulcata*, which is known as a West-Indian species; but the identification is certainly correct. Mr. E. A Smith, in the 'Challenger' Report on the Lamellibranchiata, p. 179 f, has some valuable remarks on this and kindred species. A close examination, however, of a series of specimens convinces me that with this *quadrisulcata* is identical *L. Cumingia*, Ad. & Ang. (P. Z. S. 1863, p. 426, pl. xxxvii. fig. 20, from Ceylon, Australia, New Zealand), the present shells forming a link between the two. And as Mr. Smith adds *L. eburnea*, Reeve (West Columbia), to the synonymy of *quadrisulcata*, we have a distribution of

			this shell which, though very remarkable, is not altogether unexampled.
—— MacAndreæ, *H. Ad.*	....	....	Belongs to the same type as *ornata*, Reeve. Mr. Smith, in the 'Challenger' Report referred to above, thinks the species may be the same as *ornatissima*, d'Orb., a Mauritian shell, which, however, appears never to have been fully described.
—— exasperata, *Reeve* ..	Shore; valves.	Honduras, *Persian Gulf.	If Reeve's locality (Bay of Honduras) be correct, we have here another remarkable instance of distribution of a *Lucina*, as the identification is no doubt correct. The allied species *tigrina*, L., occurs both at Bourbon and in the W. Indies (Desh. Moll. de Réunion, p. 19), also at Natal.
—— interrupta, *Lam.*	Shore, rare.	Torres Straits.	
—— Reevei, *Desh.* [fibula, *Reeve*].	Not rare.	Réunion. [Red Sea, Philippines.]	The shells are *fibula*, Reeve, which is given in the Brit. Mus. from the Red Sea.
—— pila, *Reeve* [globosa, *Forsk.*].	Shore.	[Port Jackson.]	
—— tumida, *Reeve* [=globosa, *Forsk.*].	Valves.	....	This and the preceding are the same species, the correct name of which appears to be *globosa*, Forsk.,—*tumida*, Reeve, and *ovum*, Reeve, being synonyms. In the Brit. Mus. *pila*, Reeve, is given as =*chrysostoma*, Mensch. The same authority unites *vesicula*, Gould, with *globosa*, Forsk., but this appears to me most unlikely.
—— decussata, *H. Ad.* ..	....	*Persian Gulf.	
—— picta, *H. Ad.*	Rare.	....	Suspiciously near to *bullula*, Reeve (Port Essington).
Mysia tumida, *H. Ad.*	Rare.		
Diplodonta Savignyi, *Vaill.*	Not unfrequent.	*Persian Gulf.	Journ. de Conch. 1865, pp. 124, 125; figured in Savigny, pl. viii. fig. 7, a figure which Audouin erroneously determined as *Luc. edentula*. It is sufficiently distinguished from the common *rotundata*, Mont., by

Shell.	Station.	Distribution.	Remarks.
			the comparatively square upper and sharply-rounded lower margins.
Scintilla Oweni, *Desh.*	Under stones; low water.	Philippines.	
CYPRINIDÆ.			
Circe adenensis, *Phil.* [=callipyga, *Born*].	Two specimens.	....	Reeve, probably rightly, unites this species with *callipyga*, Born, which, however, he makes a var. of *lentiginosa*, Chemn. This I should doubt.
—— arabica, *Chemn.*	Abundant; several varieties; shore.	Red Sea, *Persian Gulf.	
—— corrugata, *Chemn.* ..	Frequent; 2–5 fath.	New Holland, *Persian Gulf.	
—— crocea, *Gray* [=corrugata, *Chemn.*, var.].	Frequent; 2–10 fath.; two varieties.	Red Sea.	I regard this as a mere variety of *corrugata*, Chemn. That species varies largely in the size and number of the ridges, and also in the compression or expansion of the centre of the valves. Reeve specially describes *crocea* as varying in this latter point, and is reduced to distinguishing it by two vast rays at the umboes, which cannot count for much. The very large series before me (nearly fifty) strongly supports this conclusion.
—— lentiginosa, *Chemn.* [=arabica, *Chemn.*].	Frequent; low water.	Red Sea.	Not to be distinguished from *arabica*, Chemn., which suffers every imaginable colour-variation in the large series before me.
—— pulchra, *Desh.* [=arabica, *Chemn.*].	Not frequent; low water.	Red Sea.	A mere colour variety of *arabica*, Chemn., described in P. Z. S. 1853, p. 6. Note that *arabica*, *lentiginosa*, and *pulchra* were all found at the same station.
—— Savignyi, *Jonas* [=pectinata, Lam.].	Low water.	Indian Ocean, Philippines.	

—— semiarata, *Dunk.* [arabica, *Chemn.*].	Two specimens.	....	I cannot distinguish them from *arabica*, Chemn.
—— sulcata, *Gray*	Varieties, frequent; 2–10 fath.	Philippines.	Varieties appear to be *artemis*, Desh., and *plebeia*, Hanl.
—— lenticularis, *Desh.* ..	Rare; 6 fath.	Australia.	It may be remarked that *Circe gibba*, Lam., *divaricata*, Gmel., and *dispar*, Chemn., recorded by Issel and Reeve from the Red Sea, and *æquivoca*, Chemn. (probably only a var. of *divaricata*), recorded by Sowerby, Thes., from the same locality, do not occur in the collection.
Lioconcha castrensis, *L.* ..	Rare.	Indian Ocean.	Five very young specimens, which appear to be correctly identified.
—— picta, *Born*	Moderately rare; two varieties.	Philippines. [Sandwich Is.]	*Hieroglyphica*, Conr., is a variety in which the thread-like markings have run together here and there.
—— hebræa, *Lam.*	Rare.	Persian Gulf.	
Tellidora pusilla, *H. Ad.* [= Gouldia lamellosa, *Issel*].	Equals *Gouldia lamellosa*, Issel.	....	Described by Adams in P. Z. S. 1870, p. 6, pl. i. fig. 4, so he may not have seen Issel's book, which was published in 1869. It was a strange blunder, however, to describe a shell with such a hinge as this as a *Tellidora*.
CARDITIDÆ.			
Cardita angisulcata, *Reeve*	Rare.	....	Closely allied to *Jukesii*, Desh.; but in the present species the ribs are broader and the interstices in consequence narrower.
—— cardioides, *Reeve* [cruentata, *Desh.*].	Rare.	[Philippines.]	Two shells of different species, neither of which is *cardioides*; one specimen is *elegantula*, Desh., the other is a young shell of *cruentata*, Desh.
—— elegantula, *Desh.*....	Rare.		
—— ovalis, *Reeve*, var....	Rare; one valve.	Philippines.	Possibly correct, but differing widely from the typical form.
—— variegata, *Brug.*	Rare.	Indian and China Seas. [Port Essington, Bourbon.]	I cannot separate *radula*, Reeve, from this species.

Shell.	Station.	Distribution.	Remarks.
VENERIDÆ.			
Venus reticulata, *L.*	Shore, valves.	Philippines, Madagascar, *Persian Gulf.	Not in the collection.
Chione costellifera, *Ad. & Reeve.*	Frequent; 15 fath.	Philippines.	
—— pulchella, *H. Ad.* ..	Rare; 15 fath.	....	A very remarkable species, shaped like a *Psammobia.*
—— Römeriana, *Issel*	Frequent; 10 fath.	*Persian Gulf.	Young specimens are much more regularly triangular than old ones; in the latter the lateral margins become produced.
Callista florida, *Lam.*	Frequent; 10–20 fath.	*Persian Gulf.	In the young shell the grooves often extend over the whole surface, while in the adult they become evanescent, except on the anterior side.
—— *semisulcata, *Sow.* [= florida, *Lam.*].	....	....	Deshayes is undoubtedly right in regarding this species as a variety of *florida*, Lam. I have over thirty of the latter before me, undoubtedly connected with *semisulcata.* Every variety of colouring occurs; some are quite white, with no markings at all.
—— crocea, *Desh.*	Young; one specimen.	Philippines.	
Artemis erythrostoma, *Reeve* [= *erythræa, *Röm.*].	Shore to 5 fath.; moderately frequent.	Aden.	Issel must be dealing with rayed specimens of this species when he records *Art. radiata*, Reeve (a West-African shell), as from Suez.
—— variegata, *Chemn.* ..	Rare.	Philippines, Moluccas, Australia. [Bourbon.]	
—— hepatica, *Phil.*.....	Rare; Ras Mahommed.	Natal.	The identification is undoubtedly correct. Reeve must be in error when he says, "there is little indication of a lunule." In the specimens before me it is very well marked. Only one of these is of the colour figured by him, the others (eight)

			are much lighter, the colour being orange rather than smoky violet.
Clementia Cumingii, *Desh.*	Valves; shore.		
Tapes Deshayesii, *Hanl.* . .	5 fath.; not abundant.	Philippines. [Mauritius.]	
—— textrix, *Chemn.*	5 fath., two specimens; young.	Indian Ocean, New Holland.	
Venerupis macrophylla, *Desh.* [= irus, *L.*].	Four specimens.	Philippines, *Persian Gulf. [England to the Canaries, Mediterranean, Black Sea, Ceylon, Singapore.]	A shell whose station compels it to assume various shapes, has, as usual, fallen a victim to creators of species. These Suez shells are quite undistinguishable from the familiar *irus*, L., of which MacAndrew has a remarkably fine series from various parts of the Mediterranean. One series, in particular, from Alexandria, corresponds exactly to the Suez shells in the unusual size of the lamellæ. *Ven. derelicta*, Desh., and *fimbriata*, Sow., are synonyms, while *pulcherrima*, Desh., appears to differ only in having somewhat finer striæ.
Coralliophaga coralliophaga, *Gmel.*	One specimen.	Philippines.	Reeve's *laminata* is probably the same shell, laminæ being common to both species.
—— striolata, *H. Ad.* [=coralliophaga, *Gmel.*].	[One specimen.]	. . . .	Nothing but a young specimen of the preceding, and a shell that ought never to have been described as new.
Petricola Hemprichii, *Issel* [=lithophaga, *Retz.*].	Not frequent in Madrepore.	Philippines.	Issel's figure (Mar Rosso, Taf. i. fig. 6) represents rather too round a shell; the six specimens before me all have the posterior end much elongated. After close examination I am quite unable to separate the species from the common *lithophaga*, Retz., of the Mediterranean, while *chinensis*, Desh., and *bipartita*, Desh., will probably be found to be synonyms (P. Z. S. 1870, p. 6, pl. i. fig. 5).
Lucinopsis elegans, *H. Ad.*			

Shell.	Station.	Distribution.	Remarks.
MACTRIDÆ.			
Trigonella achatina, *Chemn.*	Rare; 10 fath.	Philippines, *Persian Gulf. [Ceylon, Nicobars, Admiralty Is., China.]	
—— olorina, *Phil.*	Frequent at low water.	Red Sea.	
Standella Solanderi, *Gray*	Shore, rare; Ras Mahommed.	Moluccas.	
Ervilia scaliola, *Issel*	Rare; 15–25 fath.	*Persian Gulf.	
TELLINIDÆ.			
Asaphis violascescens, *Forsk.* [= deflorata, *L.*].	Rare.	Red Sea. [Bourbon, Bermuda, W. Indies.]	Probably the same shell as *Venus deflorata*, L., and *Sanguinolaria rugosa*, Lam., which has a remarkable range of distribution; *dichotoma*, Ant., is another synonym.
Psammobia dispar, *Desh.*..	Rare.	Philippines.	
—— elegans, *Desh.*	Rare.	Philippines, *Persian Gulf.	*Bicarinata*, Desh., does not seem to differ; it occurs in Issel's list, while *elegans* does not, which seems suspicious.
—— pallida, *Lam.* [pulchella, *Lam.*].	Rare.	....	The shells are certainly *pulchella*, Lam.
Psammotella oblonga, *Desh.* [rosea, *Desh.*].	Common, Suez.	Red Sea.	This appears incorrect; the shells are *rosea*, Desh. There appears to exist some confusion as to what this shell really is. Vaillant finds *rosea* "très commune" at Suez, while Issel finds "un solo esemplare," but apparently finds plenty of *Ps. elongata*, Lam., which he identifies with *Rüppelliana*, Reeve. Neither of these latter are found by Vaillant or MacAndrew. Reeve,

				however, places *elongata*, Lam., in quite a different genus (*Capsella*) from his *Rüppelliana* (*Psammotella*), which seems rather against their being synonyms! It looks as if Issel had mistaken this common *rosea*, Desh. (MacAndrew has a large series of it), for *elongata*, Lam., and identified some other less common species with *rosea*, Desh.
Tellina exculta, *Gould* [= crucigera, *Lam.*].	6-10 fath.; rare; four specimens.	Torres Straits.		No doubt identical with *crucigera*, Lam. Further synonyms given by the Mus. Brit. are *gratiosa*, Desh. (non Röm.), *ornata*, Desh., *amœna*, Desh., and *vinosa*, Desh., all described in P. Z. S. 1854, pp. 369,370 (and not figured), from the Cumingian collection.
—— Listeri, *Hanl.* [hippopoidea, *Jonas*].	Shore; rare.	[Senegal.]		A misidentification. *Listeri* is not nearly so acutely angled at the margins. The shells are *hippopoidea*, Jonas, "=*striatula*, Lam. (not Oliv. nec Sowb.)," according to a note on the tablet in the Brit. Mus. in Deshayes' hand. The writer, however, of the monograph in Küster regards *hippopoidea* as a synonym of *inflata*, Chemn., and as equal to *striatula*, Hanl., non Lam.
—— Pharaonis, *Hanl.*....	Shore; rare.	Red Sea.		
—— rugosa, *Born.*				
—— Woodii, *Desh.* [=sulcata, *Wood*].	....	[Aden.]		*Woodii* is a synonym of the much older *sulcata*, Wood. Küster's monograph queries the common occurrence of the species at Suez, which is vouched for by Vaillant (Journ. de Conch. 1865, p. 121); but the series in this collection amply bears Vaillant out. The young shell has been described by Sowerby as *T. Belcheriana*. *Owenii*, Hanl., has a similar shape, but the sculpture is quite distinct.

Shell.	Station.	Distribution.	Remarks.
Tellina resecta, *Desh.*	One valve.	N.E. Australia.	This is a mistake; *resecta* is minutely cancellated, while this shell is concentrically ribbed only. I am inclined to regard the shell, which is in very bad condition, as a young form of *plicata*, Val.
—— venusta, *Desh.*	....	Sandwich Is.	
—— virgulata, *H. Ad.* [Adamsii, *Cooke*].	[Three specimens.]	....	From some mistake this species appeared in the original list as *erythræensis*, H. Ad., which is quite a different shell (see below). It is described in P.Z.S. 1871, p. 6, pl. i. fig. 3, the figure representing the shell much too long in proportion to its breadth. The name is ill-chosen, as there is already a *virgulata*, Hanl. (P. Z. S. 1844, p. 164, figured in his monogr. pl. lvi. fig. 5). I would propose its alteration to *Adamsii*.
—— silicula, *Desh.* [=rhomboides, *Quoy*].	....	[Madagascar, Philippines, Fiji.]	*Silicula* (P.Z.S. 1854, p. 363, unfigured, the locality "Columbia' being untrustworthy) is a synonym of the well-known *rhomboides*, Quoy; nor does *compta*, Gould ('Otia,' p. 79), seem to differ.
—— capsoides, *Lam.*	....	Philippines, Australia.	
—— Isseli, *H. Ad.* [= balaustina, *Poli*].	[Common.]	*Persian Gulf.	Quite undistinguishable from *balaustina*, Poli. I have examined large series of each without detecting any difference.
—— Savignyi, *H. Ad.* [= pinguis, *Hanl.*]	[Abundant.]	....	No doubt the same shell as *pinguis*, Hanl. (P. Z. S. 1844, p. 63, figured in his monogr. pl. lvi. fig. 34).
—— scobinata, *L.*	Rare; shore.	Society and Philippine Is.	
—— *arsinoensis, *Issel* ..	....	Persian Gulf.	
—— caseus, *Sow.*	....	....	Figured in Reeve (Conch. Ic. vol. xvii., *Tellina*, fig. 115), but I do not know where the type is.
—— nitens, *Desh.*	One specimen.		
—— producta, *H. Ad.*			
—— pura, *H. Ad.*			

—— triradiata, *H. Ad.* ..	[Common.]	....	All these new species of *Tellina* are described and figured by H. Adams in P. Z. S. 1870, pp. 789, 790.
—— *rosacea, *H. Ad.* [=triradiata, *H. Ad.*, juv.].	....	....	This is nothing but the young of *triradiata*, H. Ad.
—— lactea, *H. Ad.*	[One specimen.]	....	This appears to me nothing but a young and worn specimen of "*silicula*, Desh.," *i. e.* of *rhomboides*, Quoy.
—— erythræensis, *H. Ad.* [=rhomboides, *Quoy*].	[One specimen.]	....	This again is merely a form of *rhomboides*, Quoy, the sculpture especially corresponding exactly.
—— *lux, *Hanl.*	[Four good specimens.]	*Persian Gulf, Philippines.	
—— simplex, *H. Ad.*	....	....	Characterized by its smooth surface and very prominent umbonal region.
—— scitula, *H. Ad.*	[Six specimens.]		
—— pusilla, *H. Ad.*			
—— vernalis, *Hanl.*? [unifasciata, *Sow.*].	[Three specimens.]	[Seychelles, Port Jackson.]	Not *vernalis*, Hanl., which is a longer and broader shell, but *unifasciata*, Sow.
—— ovalis, *Sow.*	....	Moluccas, Philippines.	
—— truncata, *Jonas*	Valves.	Manilla.	
Scrobicularia seychellarum, *H. Ad.*	Rare; 10–20 fath.	Seychelles.	
Semele Macandreæ, *H. Ad.*			
Mesodesma glabratum, *Lam.*	Frequent; 2–10 fath.	Australia. [Bourbon, Ceylon.]	
SOLENIDÆ.			
Solen aspersus, *Dunk.*	Two specimens, young; 10 fath.	Japan.	
—— corneus, *Lam.*	10 fath.	Philippines. [Japan.]	One specimen only, in such bad condition that I should not like to confirm its identification.

Shell.	Station.	Distribution.	Remarks.
Cultellus marmoratus, *Dunk.* [= cultellus, *L.*].	Rare; 10 fath.	....	*Marmoratus*, Dunk., appears to be the young of *lividus*, Dunk.; but probably both are only varieties of the variable *cultellus*, L.
Solecurtus coarctatus, *Gmel.*	Rare; 10 fath.	Britain, Mediterranean, &c. [Nicobars, New Guinea.]	It is very doubtful whether this identification is correct, at least in the sense intended by MacAndrew. The specimens (three perfect and two valves) are all young, and decidedly of a thinner texture and less solid epidermis than the "*coarctatus*" of our own and the Mediterranean coasts. The shell, too, appears slightly longer in proportion to its breadth. But Jeffreys is probably right in regarding our British shell as *antiquatus*, Pult., *coarctatus* having been originally described by Gmelin from the Nicobars.
MYIDÆ.			
Sphænia Rüppellii, *A. Ad.*	Three and a half specimens in coral.		
Corbula sulculosa, *H. Ad.*	Frequent; 20-40 fath.		
—— erythræensis, *H. Ad.*	Rare; 20-40 fath.	*Persian Gulf.	
Neæra pulchella, *H. Ad.*...	Rare; 10-30 fath.	....	A good species, differing from *Gouldiana*, Hinds (Singapore), in having no projecting plate before the beaks, and from *singaporensis*, Hinds, in having much fewer ribs.
Eucharis angulata, *H. Ad.*	One valve.		
Cryptomya decurtata, *A. Ad.*	One valve.	Philippines.	

ANATINIDÆ.			
Anatina subrostrata, *Lam.*	Shore; not rare.	....	*Eximia*, Reeve, and *flexuosa*, Reeve, do not appear to possess a difference entitling them to specific rank.
GASTROCHÆNIDÆ.			
Gastrochæna Retzii, *Desh.*	One specimen.	Réunion.	I have not been able to verify this.
——Rüppellii, *Desh.* [dubia, *Penn.*].	Frequent.	[S. Britain to Canaries, Teneriffe, and Cape Verds, Mediterranean.]	The shells appear quite inseparable from *dubia*, Penn., which Weinkauff (Conch. des Mittelm. i. p. 3) has received from the Red Sea. The whole genus contains far too many species, and wants thorough revision.
Aspergillum vaginiferum, *Lam.*	Shore, broken.	Red Sea.	
PHOLADIDÆ.			
Pholas erythræa, *Gray* [? = dactylus, *L.*].	One valve.	....	It seems very doubtful whether the type shell at the Brit. Mus., from which this has been named, is anything more than *dactylus*, L.
Guetera lagenula, *Gould* [=cymbium, *Spengl.*].	Shore, on shells; rare.	*Persian Gulf.	*Gastrochæna cymbium*, Spengl., is the same shell, and it would be hard to find a valid point of difference for *pupina*, Desh.

XIII.—*A new Form of Freshwater Cœlenterate.* By Dr. M. Ussow *.

[Plate IV.]

The parasite of the eggs of the Sterlet, first described by P. Owsjannikow † and somewhat later by O. Grimm ‡, constitutes only a stage in the development of a Hydroid organism living free in the Volga.

Although the form of the body, the mode of life, the development, and the anatomical structure of this animal indubitably indicate its cœlenteric nature and approximate it to the Hydromedusæ, the generic characters of the latter apply so little to our organism, that it appears not unadvisable to give it a new name, and I will call it *Polypodium hydriforme*. Since March 1884 I have occupied myself with the investigation of this form, and I am preparing a large memoir for the press; at present I shall only notice in a few words the anatomical structure and the more important vital phenomena of this peculiarly interesting animal.

As regards its mode of life and development, we meet with *Polypodium* in three stages, namely:—1, as a parasite in the eggs of the Sterlet (*Acipenser ruthenus*), in the form of a cylindrical, spirally-twisted tube, furnished with numerous lateral buds; 2, free, frequently dividing, provided with 24, 12, or 6 tentacles; 3, as I suppose, as a sexual animal. The transformation of the free-living into the sexual form has not hitherto been demonstrated (September 1885), notwithstanding the successful culture of the animal in the aquarium; I must therefore speak of it hypothetically, basing what I have to say upon the first two developmental stages.

As regards the disease of the eggs of the Sterlet, we may remark as follows:—1. The number of infected fishes is to that of the healthy ones as 2 : 10. 2. The disease is dependent on the age of the animals, and in large fishes of 50–70 centim. in length we find diseased ovaries more frequently than in fishes of 20–25 centim. 3. Sterlets which have been long kept in fish-barges harbour more parasites than freshly

* Translated by W. S. Dallas, F.L.S., from the 'Morphologisches Jahrbuch,' Band xii. pp. 137–153.

† "Arbeiten der dritten russischen Naturforscherversammlung in Kiew" (ref. in Zeitschr. f. wiss. Zool. Bd. xxii. p. 292), 'Mélanges biologiques de l'Acad. des Sci. de St. Pétersb.,' 1871.

‡ 'Arbeiten der Naturforschergesellschaft in Petersburg,' 1873, Taf. ii. (Materialien zur Kenntniss d. nied. Organismen, 3. Dissertation).

captured ones. 4. Light-coloured ovaries (ova with light-coloured yolk) are more subject to the infection (the colour of the yolk depends not so much upon the age as upon individual peculiarities of the Sterlet) ; in yolks containing much fat and of a yellowish-red colour the parasites live only for a short time and then succumb. 5. Those fishes which are brought from lower down the Volga are more infected than those of this part [Kasan]. The disease prevails most strongly during four or five months, from August to January, and perhaps also rather longer, as in May still young secondary buds have been found along with perfectly developed larvæ.

No external symptoms of disease are perceptible in the Sterlets; and even an infected roe is in no way distinguished from the normal one upon a superficial examination. This is due to the fact that our parasite lives in the interior of the ova, and at the commencement of this phase of development remains nearly motionless. The picture changes, however, after the ovary has arrived at full maturity, and the completion of this developmental stage of the parasite, both happening in most cases at the same time, the end of April and in May; the chorion of many infected ova, stretched by the parasite, which is at this time full-grown, bursts prematurely, *i. e.* before the Sterlet has spawned, and the roe is then in places traversed by a whitish slime, consisting of dead and partially macerated *Polypodia*, for the latter must pass directly from the ruptured chorion into fresh water in order that they may continue to thrive. Infected ova of 3–4 millim. in diameter * are at first in no way distinguished from healthy ova either in the structure of their envelopes or in the nature of the yolk, or in their relation to the blood-vessels. They differ from the healthy ova by their diameter being 1–2 millim. greater, and on careful examination strike one by the presence of a spirally-running band with undulated edges over the whole surface under the envelopes, through which it shows milk-white (Pl. IV. figs. 1, 2). By this means the whole structure, to compare it with something, reminds one of a marble Easter-egg. With an advanced development of the parasite the colour of the yolk changes to dark brown, which is caused by the intermixture of minute granules, secretion-products of the ectodermal cells of the parasite.

The youngest stage observed by me in the development of the parasitic form (A) of *Polypodium hydriforme* constituted a

* I have found no parasites in smaller, and therefore younger, ova. It is to be supposed that the parasites in the young stage live free and only get into the ova of the Sterlet long after these have begun their development.

cylindrical, hollow, and cæcal tube (Pl. IV. fig. 3), 15–17 millim. long and $1\frac{1}{2}$–2 millim. in thickness, which was covered on the surface with primary buds (*a*).

The walls of this tube consist of a single layer of *ectoderm* and a single layer of *endoderm*. Even in the youngest developmental stages we observe also over the whole body between these two layers, but more closely applied to the ectoderm, some elongated fusiform cells; they form a unitary muscular layer, which in further growth becomes sharply marked—the *mesoderm*.

Simultaneously with the advancing formation of a muscular lamina, the cord-like body, alternately contracting and extending itself in the direction of its length, twists itself into a spiral (of three or four turns). This surrounds a central yolk-mass, while a few yolk-globules pass to the periphery of the ovum through the turns of the spiral, and take their place between the chorion and the primary buds. The spiral turns follow the long axis of the spheroidal ovum of the Sterlet. The primary buds upon the body of the parasite, which has neither mouth nor anus, have at first the appearance of not very strongly marked rounded swellings, which, by the constriction of their base at the body of their bearer, gradually become distinct and acquire a pyriform shape. The axial cavity of the general bearer is then continued into the spacious cavity of each bud, the delicate walls of which form a continuation of the three cell-layers, the ecto-, meso-, and endoderm.

Soon after the pushing out of the buds there appears upon each of them a slight furrow, which gradually deepens and effects the division of each of the primary buds into two likewise pyriform bodies, the *secondary buds* (fig. 4). These, in the sequel, become developed into free-living forms (mothers). Each eight secondary, representing four primary buds, takes part in a complete spiral turn $(4 \times 8 = 32)$, at the same time they bend at an angle to one another during the twisting of the general support (*stolo**), and place themselves all on one side of the stolo. The side of the parasite which is free from buds is turned towards the central yolk-nucleus, while the upper parts of all the thirty-two buds are turned towards the peripheral yolk, or the chorion.

Upon the upper part of each secondary bud there is also a slight furrow, which, however, does not penetrate deeply, but only indicatively divides the cavity of the bud into a right and

* I shall make use of this designation, although, as will be seen hereafter, this part does not represent morphologically a stolo *sens. strict.*; I choose the expression merely for convenience.

a left half. The direct union of this cavity with the axial cavity of the common support takes place through the peduncle of the bud, which diminishes in size at this time. By transmitted light the common support, as well as the buds, appears perfectly transparent; by direct light, as already stated, milky white with a bluish tinge. The cavity of the buds and the stolo is filled with a fluid which coagulates on the application of reagents. In this phase of development the endodermal cells appear in sections distinctly contoured, with a readily recognizable large nucleus; their protoplasm is transparently granular, and permeated in the part turned towards the bud-cavity by a great number of vacuoles, side by side with which yolk-globules are to be found here and there in small numbers. In the ectoderm, which is in contact with the yolk, on the contrary, all the cells are filled with yolk-globules. The latter are taken up by the ectodermal cells directly and without first breaking up. In the wall of the stolo opposite to the buds, and turned towards the central yolk-nucleus, the ectodermal cells are just as transparent as those of the endoderm and contain no vitelline globules.

From this it follows that in the vermiform organism parasitic in the ova of the Sterlet and investigated by me, the *process of nutrition* which is more and more actively carried on during the gradual growth of the primary and secondary buds, is exclusively performed by the ectodermal cells of the buds, *the vitellus of the ovum, which is energetically incepted by the latter, penetrating through the endodermal cells into the bud-cavity, where it collects in the form of reserve nutritive material.*

The development of the buds concludes with their most complete possible separation from one another and with the appearance of tentacles.

The upper part of the secondary bud, with the above-mentioned shallow groove, represents the lower aboral end of the future free-living form; and the furrow running parallel to the long axis itself indicates the direction of the plane of division which in the sequel halves the free-living generation, the "mothers."

Twelve previously-forming tentacles, six on each side of the bud, in the neighbourhood of its peduncle, as well as the other twelve secondary tentacles, likewise appearing above, six on each side of the longitudinal groove, are developed *with the co-operation of all the three cell-layers of the bud* (but especially the mesoderm). They grow *from without inwards* into the cavity of the bud, in the fashion of introverted glove-fingers (fig. 4).

Of the twenty-four tentacles (figs. 7 and 8) eight subsequently become differentiated (four above, I'.–IV'., and two on each side of the bud, I.–IV.) as shorter, but at the same time stouter, protractile tentacles, clavately enlarged at the end, which I shall name feelers (*Senktaster*). At their extremities they are provided with numerous urticating elements, developed in special cnidoblasts, and they have the appearance of filiform, clavate, simple structures without any special armature.

The other sixteen tentacles are placed in pairs symmetrically on the two sides of the bud; they are thinner, but considerably longer than the feelers. Further on, in the description of the free-living mother-form, the different functions of these tentacles will be mentioned.

At the commencement of the spawning-season, in the first half of May, a great part of the buds have already turned out the tentacles (fig. 5); but it is to be noted that even on the buds of the same stolo this process by no means takes place simultaneously. This delay in the development may frequently be observed in the whole of the infected ova of a roe; then the parasites become soft and apparently perish. Their colour in this case passes into a greenish tint, while the yolk surrounded by them acquires an abnormal yellowish-red coloration. The period at which the tentacles are everted forms a turning-point in the existence of our animal. From a sluggish parasitic form enclosed in a narrow space within the envelopes of the ovum of the Sterlet there originates an active generation; the stolo with the well-developed buds begins to move, and in consequence of this there frequently arises, even in the interior of the Sterlet before spawning, the possibility of a rupture of the egg-membranes, which are very thin at this time, and of the liberation of the parasite. To this liberation, however, the friction of the Sterlet during the spawning, and in fact the whole spawning-process, is particularly favourable.

Whilst at the beginning of its development, residence in fresh water, even of short duration, was destruction to the parasite, it cannot now develop itself further without water.

If we examine an infected ovum during the spawning-period, we no longer find any yolk in it outside the parasite, but instead of it the remains of a brown excretion-product of the animal, and the whole of the yolk not assimilated by the buds has passed into their interior space, by which a change of their colour to yellowish is produced.

In the course of a further sojourn of twenty-four hours in the water, the entire stolo breaks up into thirty-two pieces,

corresponding to the above-mentioned thirty-two buds. The separation of the thirty-two parts of the parasite generally follows a regular course, *i. e.* the complete spiral turns (each consisting of eight buds) first of all separate; these small chains are then successively halved, so that we get pieces representing four and then two buds, and then finally thirty-two isolated individuals.

Soon after the appearance of the secondary buds these in growing change their rounded pyriform shape, become angular, and acquire the form of two low trapezia with their bases placed together and resting upon a cylindrical pedestal (the peduncle). The anterior or upper trapezium, with the longitudinal groove (the upper division of the bud) which bears the twelve secondary tentacles, corresponds, as I have already remarked, to the aboral extremity of the future free-living form (mother). The hinder or inferior trapezium, on the other hand, which rests upon the cylindrical peduncle (the lower part of the bud) and which bears the twelve primary tentacles, becomes the oral end in the free-living generation. After the breaking up of the stolo, the peduncle and a part of the stolo itself are converted into a movable proboscis, with the buccal orifice, which afterwards breaks through, at its extremity.

On examining serial sections of an individual already separated and furnished with external tentacles, we observe considerable alterations in all the three layers of the body-wall. No longer containing any yolk-particles, the cells of the ectoderm are quite transparent, and divide rapidly parallel to their radial walls; at the same time they rise at the surface of the body into folds, so that this, in consequence, appears wrinkled. However, neither at this time nor at a later period does this lamina appear composed of more than one layer, but always only folded. Here and there cells of the subjacent mesoderm protrude from it and push their way into the ectoderm; these cells contain urticant elements. This character is presented very distinctly in the tentacles, and especially in the extremities of the feelers. The mesodermal cells not only serve for the construction of the longitudinal muscular fibres, but, as it appears to me, they also furnish the cnidoblasts, which penetrate into the epithelial covering of the body. The muscular layer consists of spindle-shaped cells with very sharply contoured nuclei, and is closely applied upon the ectoderm. The adhesion of these mesodermal cells to the ectoderm is, as I have already remarked, not perceptible in the first stages in the primary buds; here they are rather isolated.

About the time of the breaking up of the stolo the muscular fibres have acquired the appearance of broad, thin, very contractile, smooth muscular bands, with thin edges touching each other.

Further in we come upon the *unilamellar endoderm.* Nevertheless we observe between the endodermal cells, which are rendered very turbid by the deposition of yolk-particles, and the muscular layer, an interspace which is constantly becoming more sharply marked. This fissure, which narrows by the application of reagents and which extends to the extreme tip of the tentacles, is filled with a clear fluid; the latter is traversed by a fine web of anastomosing protoplasmic runners of the endodermal cells. During contractions of the body and tentacles the lumen of this fissure becomes smaller, which would indicate that these runners of the endodermal cells are themselves also contractile.

At the commencement of my investigation I was inclined to regard the above structure as a kind of supporting lamella, until I subsequently convinced myself that such a thing does not exist in our animal.

In the interior of the endodermal cells we find, besides their large nucleus, many yolk-globules, and, further, a quantity of dark-brown particles, which I would regard as a product of the decomposition of the latter.

It has already been remarked that during the breaking up of the stolo all the bud-cavities are filled with yolk, and that this passes through the ectoderm into the bud, for there are no openings in the wall either of the buds or of the stolo; and a further proof of such an immigration of the yolk-globules is furnished by the circumstance that in ova with developed *Polypodia* furnished with everted tentacles no yolk is to be met with outside the parasite. *Consequently the nourishment of the buds individualized after the breaking-up of the stolo is effected at the expense of the yolk contained in their cavity,* and this cavity may then, especially after the breaking-through of the buccal aperture, be designated the *gastral cavity.* Its *diverticula,* which are at first broad and then narrowed conically, *traverse the tentacles to their tips.*

Thus, to summarize what is stated above, we have in *Polypodium hydriforme* a vermiform body (A) on which are formed first of all primary buds (*a*), and then from these secondary ones (*b*), and which after five or six months of parasitic existence breaks up into thirty-two hydriform organisms, living free in the Volga, 2 millim. long and 4½ millim. broad, furnished with twelve lateral and twelve inferior tentacles, whence the name *Polypodium hydriforme.* The body-wall

consists of the ectoderm and muscular layer, while the endoderm forms the wall of the paired cavities, which extend into the tentacles and communicate with the surrounding medium through the buccal aperture, which is situated in the middle of the upper part of the mobile protrusible proboscis.

As the development of the *Polypodium* does not conclude with the form above described, we may, with reference to its relations to the following, likewise free-living, generation, designate it as the "mother-form" (B). The mode of increase, however, still (and apparently for a long time) continues to be asexual, and when it becomes sexual subsequent investigations will probably show, as I have not succeeded, as already stated, in discovering the sexually mature form.

Under normal conditions the mother-form (B) provided with twenty-four tentacles (figs. 7 and 8) produces two daughters by regular division, *i. e.* halving (B^1, figs. 9–11), each with twelve tentacles. These then divide further, each giving origin to two different grandchild-forms (B^2 and B^2b, figs. 12, 13), each of which has six tentacles, which in both forms of the last generation attain different lengths *.

This is the ordinary course of increase; but, as subsequent observations have shown me, it does not remain stationary at the grandchild-form; but not only the two grandchild-forms, but also the daughter-generations, again reproduce the mother-form or grandmother-form (B) by rapid growth and new formation of the deficient number of regularly arranged tentacles (figs. 14, 15). This is evidently not sufficient to produce the numerous progeny of the primary form (B), for by the cultivation of the free-living animals I have collected indubitable facts which prove that the second form with twenty-four tentacles, originating by the new-formation of tentacles just mentioned (which I will designate αB), divides again and produces a second daughter-generation (αB^1) and a second grandchild-generation (αB^2 and αB^2b). It is remarkable, however, that the last generation again consists of two forms, one of which is smaller and has shorter tentacles than the other.

As each of the thirty-two buds (b) of the common stolo (A) divides further as the free-living form (B), we obtain as the final result of this division from each stolo about five hundred great-grandchild forms (αB^2 and αB^2b).

In comparison with the slow process of development of the

* It may be remarked here that the best means of fixing the tentacles, which react to the slightest irritation, is the cocaïne solution quite recently recommended by Prof. Richard (Zool. Anzeiger, no. 196). By means of this we obtain preparations very true to nature.

secondary buds (b) the increase by division of the free generation takes place very rapidly. The forms B and B^1 appear on the second or third day, and then, after a short delay, the form αB appears on the fifth or sixth day. The last generation that I obtained (αB^2 and $\alpha B^2 b$) appeared on the tenth or twelfth day. This form remained constant during from eighteen to twenty days; but it is not impossible that under more favourable circumstances * it again repeats the mother-form, and thus would furnish a third mother-generation (βB); this, however, is a mere supposition, proved by no facts. Be this as it may, it seems to me that the facts collected by me indicate that the future sexual animal is to be sought in the grandchild-form bearing six tentacles, and that all the other generations described may be called nutritive and nurse forms †.

Diagram to represent the gradual increase of the different generations of Polypodium hydriforme.

$$
\begin{array}{l}
A \\
| \\
a \\
b = B \;.\;.\;. \qquad b = B \\
\qquad B^1 \;.\;.\;. \qquad B^1 \\
\qquad B^2 = aB \;.\;.\;. \qquad B^2 b = aB \\
\qquad\qquad aB^1 \;.\;.\;. \qquad aB^1 \\
\qquad\qquad aB^2 = (\beta B \;.\;.\;.) \;? \qquad aB^2 b = (\beta B \;.\;.\;.) \;?
\end{array}
$$

The power of replacing lost parts of the body is developed in a very high degree in our animals; it is to be observed most distinctly in the region of the tentacles. These, for

* Notwithstanding the constant change of water by a stream in my aquaria, we could not succeed in keeping all the described forms alive longer than three weeks. Nourishment was apparently effected in the normal way by spores and Infusoria; but nevertheless there was a want of some conditions which I have not yet been able to make out.

† If my supposition should prove correct, the whole cycle of development of *Polypodium hydriforme* may be briefly expressed graphically in the following way:—

$$A—b—xB—C \; (i.\,e.\; B^2,\; B^2 b,\; aB^2,\; aB^2 b)—D—A.$$

From the hypothetical sexual form C originates the larva D, which penetrates into the ovum of the Sterlet and then becomes converted into the parasitic form A.

example in the form B, may all be replaced by new ones, which sprout forth in the same number, of the same structure, and at the same place as the old ones. Thus, for example, the tentacles of a *Polypodium* in stagnant and somewhat tainted water die off and become macerated down to their roots. We have only to place an animal thus mutilated (the generation is of no consequence) in fresh flowing water in order to see how, within only a few hours, small tubercles are formed in the places of the old tentacles, and these in three or four days grow into tentacles nearly of the normal length (five or six times the length of the body). During this process of reproduction of new tentacles the body proceeds to divide; thus, for example, a mother B and even αB divided, after a horseshoe-shaped constriction, into the daughter-forms B^1 and αB^1 with twelve tentacles.

I pass now to the description of the external form and structure of the body in the mother-, daughter-, and grand-daughter-generations.

I have already shown that, parallel with the gradual development of the parasitic generation, the pyriform body of the secondary buds (*b*) acquires a trapezial form by flattening in the transverse axis, with a groove at the upper and a peduncle at the lower end.

On the breaking up of the stolo the liberated buds, by the deeper impression of the transverse furrow, acquire the form of a horseshoe, the two arms of which terminate in cubical enlargements. Provided with a small fragment of the stolo and at first with a common peduncle, the buds, which separate in pairs, after definitive isolation acquire a conical proboscis with a transverse buccal fissure. Upon each of the two sides of the horseshoe there originate twelve tentacles, three pairs on each of the shoulders and three pairs at the free extremities on each side of the furrow $(\frac{6+6}{6+6}=24)$. The tentacles in each of these four regions of the body may be divided into a pair of feelers and two pairs of radial tentacles. I employ the latter expression for the sake of brevity; they originate with a common base and diverge radially, and are thinner, longer, and much less sensitive than the feelers, which bear nettling batteries at their extremities.

After the division of the mother-form each daughter acquires half the tentacles $(\frac{4+2}{4+2}=12)$. In the same way there come to each of the grandchild-forms, after the division of the daughters, six tentacles $(\frac{2+1}{2+1}=6)$, two pairs of radial tentacles, and one pair of feelers. Thus we obtain from each side of the horseshoe-shaped generation B a form B^1, and this again

divides into two B^2. The proboscis with the buccal aperture takes part in all these halvings, the buccal fissure being halved by longitudinal partitions (walls of the proboscis itself).

The radial tentacles serve our animals chiefly for locomotion and for grasping, whilst the feelers may rather be regarded as offensive and defensive weapons. Jointly they support the body in the resting state upon the bottom of the vessel, so as to produce an appearance as if it stood upon stilts, when the proboscis with the buccal aperture is placed at a considerable distance (5–6 millim.) above the bottom (fig. 11). From time to time one or other of the tentacles bends, bringing its extremity to the buccal aperture, when the lips, by very appropriate movements, strip off the mucus and with it spores and other micro-organisms (Infusoria, and frequently also Rotatoria) stupefied by the urticating elements. In the forms B and B^1 the coordination of the movements to one another upon the opposite sides of the body is generally well marked and the equilibrium is lost (thus, perhaps, favouring the separation of the halves of the body), especially upon external irritation, only during the process of division into two new individuals.

Without entering here into a detailed description of the histological structure of the free-living generations, I will at present only remark briefly as follows:—

1. *The ectoderm* appears more strongly folded on the sides and lower part of the body; between the ectodermal elements rather elongated cells are to be observed, which are produced into capillary bacilli projecting beyond the surface of the ectoderm. To all appearance we have here to do with sense-cells; they are met with most numerously at the inferior furrows.

At each side of the buccal aperture two rounded cell-aggregations are observed in the proboscis at its passage into the body, consisting of larger elements than the ectodermal cells. Their structure, I think, justifies our interpreting them as ganglia. Whether nerves are also present, perhaps forming an œsophageal ring, is unknown to me at present. After living freely for two or three days, and the complete assimilation of the yolk-mass contained in its interior, the body of the *Polypodium* acquires a light greenish colour, due to pigment-granules which are suspended in the protoplasm of the ectodermal cells.

2. *The endoderm* likewise forms an enlargement at the aboral end of the body at the sides of the transverse furrows (especially in the mother-form B). In the region of the proboscis also there is a small annular fold, which projects

freely into the internal space, and perhaps constitutes a primitive infundibuliform stomach-tube. In the formation of the buccal opening the endoderm passes directly into the ectoderm. On passing into the tentacles and in their further course in these the endodermal cells coalesce here and there, in consequence of which the lumen becomes very indistinct. A similar intimate union of the endodermal elements occurs also in the large interior spaces (two paired lateral gastral pouches) of the generations B and B^1.

3. *The mesoderm,* which runs between the ectoderm and entoderm in the form of a muscle-fibre layer scarcely perceptible in transverse sections, is strongest in the proboscis and at the points of attachment of the tentacles. At the transverse furrows of the aboral end of the body, on the other hand, the muscle-fibre layer appears to be rudimentary. These conditions are brought about by the altered mode of life of our animal, which now, as already remarked, rests upon the tentacles and moves about with their assistance.

As regards the contractile processes of the endodermal cells, which traverse the fissure between the endoderm and mesoderm perpendicularly to the body-layer, the free-living *Polypodium* presents about the same picture as the buds of the parasite.

Appendix.

On my return to Kasan I obtained five Sterlets, all with roes, on the 5th September, and in three of them I found the following:—

1. An unusually developed state of the secondary buds (*b*) for this season of the year. Many of these were in the phase in which the tentacles are everted. Two ova contained stolons with perfectly developed buds. After being transferred into flowing water one of the stolons perished on the same day, while the others divided quite normally into individuals of the generation B, which lived for a whole week in the aquarium. What may have been the cause of these specimens having remained retrograde in their development at the spawning-time of the Sterlet in the preceding May is a question difficult to decide, and it is at any rate to be supposed that these buds must have perished, as it would have been only in next May that they would have had the opportunity of quitting the ovum and acquiring their freedom, during the spawning of the Sterlet.

2. Among the infected ova I found, on the 6th of September, two smaller examples, each of which contained a larva

of *Polypodium* which was not yet developed into a stolon. These were distinguished by their smaller dimensions (0·7 millim.), and had the appearance and structure of a planula, although they were destitute of ciliation (which, however, may have been lost after their entrance into the ova of the Sterlet). Such an embryo has a large central cavity, which, I suppose, has originated by delamination.

The single-layered ectoderm has the same character as in the stolo which is just beginning to bud. The fusiform elements of the muscular layer are not yet recognizable. The single-layered endoderm shows just as little difference from that of the subsequent stage of the stolo, and has the form of a blind sac, the walls of which only touch the ectoderm at one point where they are united with it.

That this form belongs to the developmental cycle of the *Polypodium* is shown, on the one hand, by the character of the cells of which it consists, and, on the other, by its being found in the ovum of the Sterlet, surrounded by yolk. As a definitive proof, however, it would be desirable to observe earlier free-living developmental phases of this larva, and to trace their change of form into the elongated sac (stolo) which forms the primary and secondary buds.

It appears to me that from all that has been stated the Cœlenteric nature of our animal is sufficiently clear, as also its belonging to the Hydroidea. The very long course of development of *Polypodium* may, in my opinion, be easily explained by the parasitism of the larva (D), which, as is the case in *Cunoctantha*, grows into the stolo (A), which, after the formation of the buds *a* and *b*, divides into the free-living individuals of the generation B. The further division and production of the generations B^1 and B^2, and especially the secondary (αB, αB^1, and αB^2) and tertiary (βB, βB^1, βB^2) generations, may be more difficult to explain, and the more so as we do not know their transformation into the sexual animal (C).

The whole character of the ecto- and endodermal cells reminds one most of *Hydra*; the separation of the muscular lamella from the ectoderm it has in common with *Myriothela*.

If we mentally imagine the lower part of the body (the primitive foot) of generation B somewhat more elongated, we obtain, as it were, two circlets of tentacles, which are situated close to and at the side of the buccal aperture. The latter, placed at the apex of the proboscis, leads into the primitive

stomach, the walls of which, as has been remarked, are formed by the annular fold of the endoderm.

The gastrovascular space, dilated laterally into two symmetrical pouches, is continued into the hollow tentacles. In these there are no cartilage-cells, but endodermal elements, which often coalesce and, as it were, form a transition towards cartilage elements.

In a word, we have in our *Polypodium* a Hydroid organism, the motile "trophosome" (B) of which, after several asexual generations differing in the form and number of the tentacles, becomes (as may be supposed) converted into the sexual animal, the planula of which penetrates into the ovum of the Sterlet, and living there as a parasite, gradually develops into the stolo (A) with all its primary and secondary buds. Here therefore a complicated metagenesis must be assumed, during which the forms B, B^1, B^2, &c., up to the sexual animal, perform the parts of nutritive and nurse-generations of a still unknown cell-complex (of ecto- and endodermal origin), which, in the last form (C), becomes the place of formation of the sexual organs.

It would not surprise me at all if the club-shaped polypoid of the grandchild-generation (B^2, fig. 13) were to become converted into a Medusoid sexual form, and, indeed, by the outgrowth of the lower part of the crown of the club-shaped body, by an annular fold, into a small bell with four marginal filaments and two lateral tentacles, when the gastral cavity would become more sharply separated into a ring- and four radial canals.

EXPLANATION OF PLATE IV.

[All the drawings made from living specimens. Statement of enlargements only approximate.]

Fig. 1. An infected ovum, with a spirally twisted parasite in its interior (stolo with buds). ×5.

Fig. 2. A similar ovum, seen from one pole. ×5.

Fig. 3. Stolo, with sixteen primary buds. ×4.

Fig. 4. A group of secondary buds in union with the stolo. ×5. The introverted tentacles are seen shining through. Their arrangement at the side of the buds is shown in the second bud.

Fig. 5. Stolo bearing thirty-two developed buds with everted tentacles, taken from the ovum of the Sterlet at spawning-time. ×3.

Fig. 6. Two secondary buds at the time of the breaking up of the stolo and formation of the mouth. Some of the lateral and basal tentacles are retracted. ×15.

Fig. 7. Mother-generation (B) of *Polypodium hydriforme* furnished with twenty-four tentacles. ×9. Twelve tentacles (4+2+4+2) originate on the sides, and twelve (4+2+4+2) below. The

drawing was taken, during the resting state of the animal, from above, from the oral surface.

Fig. 8. Mother-generation (B) from the side. The animal was drawn while irritated by the pressure of the glass cover. The eight superior and eight inferior radial tentacles are bent upwards and conceal the proboscis with the mouth, while the four superior (lateral) and the four inferior short, clavate feelers project below. The endoderm of the central and two lateral gastral cavities is perceptible through the transparent ectoderm, as also the axial cavities in the tentacles. ×8. (Compare figs. 6, 11, 12, 13, and 15).

Fig. 9. One of the paired daughter-forms (B^1) produced by the halving of the mother, shown in figs. 7 and 8. In a state of rest from the oral side. Eight radial tentacles and four feelers, two of which are longer than the others. ×10.

Fig. 10. The same form from the side, showing the insertions of the tentacles, with the continuations of the gastral spaces. The proboscis with the mouth is below; above are the four feelers, laterally the eight radial tentacles. ×10.

Fig. 11. The same form from the side, in a state of rest, standing upon all the twelve tentacles. The body is lifted up and the proboscis directed upwards. ×10.

Fig. 12. First form (B^2) of the grandchild-generation, with four long radial tentacles and two feelers. This form has been produced from the lower half of the daughter B^1, shown in fig. 9. ×12.

Fig. 13. Second form ($B^2 b$) of the grandchild-generation, produced from the upper half of the same daughter-form (fig. 9), with shorter tentacles than the form B^2 (fig. 12). While being drawn the four radial tentacles, directed upwards, were slightly retracted *.

Fig. 14. Second mother-generation (a B) with the tentacles thrown off, their places of origin being indicated by the lateral and basal tubercles of new tentacles in course of formation. × 10.

Fig. 15. The same specimen drawn thirty-six hours later, with twelve newly-formed tentacles on the aboral side, and twelve tubercles of increased size, which in the sequel will grow into lateral radial tentacles and feelers. ×18.

XIV.—*Description of a new Species of* Vesperugo *from North America.* By G. E. Dobson, M.A., F.R.S.

Vesperugo Merriami, n. sp.

Smaller than *Vesperugo pipistrellus*, with which it agrees in general subgeneric characters; ears shorter than the head, shaped somewhat like those of that species, but the outer margin of the conch is much less deeply emarginated, and the projecting part of the lower half of the same margin is folded backwards; tragus broad, the outer side of its upper half

* Similar specimens were observed by Owsiannikow and Grimm, and figured by them with abnormally extended and already somewhat macerated tentacles.

evenly convex to the broad tip, the internal margin concave, at the base of the outer margin a longitudinally-directed lappet, succeeded above by an emargination, above which the outer margin is evenly convex; pollex short, feet very small, postcalcaneal lobule shallow, extreme tip of the tail alone projecting; the interfemoral membrane is naked above, except at the root of the tail, beneath a few short hairs appear along the transverse lines: fur pale yellowish brown on both surfaces, paler beneath, the basal half or more of the hairs dusky; margin of the wing-membrane from the last finger to the foot whitish.

Upper incisors unicuspidate (as far as can be seen from a single specimen), the inner one on each side much longer and thicker than the outer, which is close to it; lower incisors placed in the direction of the jaws; first upper premolar very small, in the angle between the canine and the second premolar, and not visible from without, although the cusp of the second premolar is widely separated from that of the canine owing to the projecting anterior part of the cingulum of the former tooth; the first lower premolar is much shorter than the second, which considerably exceeds in height the cusps of the molars.

This is the smallest species of the subgenus yet described, the forearm scarcely exceeding an inch in length. That the single specimen known is full-grown is proved by the worn state of the teeth and perfectly ossified condition of the finger-bones. It somewhat resembles *V. abramus* of the Old World, but may be at once distinguished by its unicuspidate upper incisors and by the lower incisors being placed in the direction of the jaws, by the shape of the second upper and lower premolars, by the small size of the first lower premolar, by the very differently-shaped tragus, and finally by the conspicuously small size of the animal. The discovery of this species is of peculiar interest, as it belongs to a subgenus which, though largely represented in the Old World, is very restricted in the New.

Length (of an adult male): head and body 1″·5, tail 1″, head 0″·5, ear 0″·38, tragus 0″·18, forearm 1″·05, pollex 0″·15, middle finger 1″·6, fifth finger 1″·2, tibia 0″·4, foot 0″·2.

Hab. North America (Locust Grove, State of New York).

I have much pleasure in connecting with this very interesting species the name of its discoverer, Dr. Clinton Hart Merriam, author of the 'Mammals of the Adirondacks,' who has done so much to extend our knowledge of the mammalian fauna of the Nearctic Region.

XV.—*Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia, continued.* By H. J. Carter, F.R.S. &c.

[Continued from p. 55.]

Order VIII. CALCAREA (*continued*).

Observation.

We now come to Calcareous Sponges wherein the spicules and sarcode apparently do not present any definite arrangement like that of the foregoing species, but, on the contrary, one in which both are apparently mixed together confusedly, so as to form a cancellated mass, which is traversed by a branched system of excretory canals identical with that of the non-calcareous sponges, the former representing the parenchyma and the latter the channels of the excretory system.

To this structure the name of "*Leuconia*" was given by Dr. Bowerbank in 1864 (Mon. Brit. Spong. vol. ii. p. 2), ex. gr. *L. fistulosa* (*Leucandra fistulosa*, H.), and the same name will be adopted here.

Häckel put these sponges into his second family under the name of "*Leucones*," which he has divided into genera; but at present I can only give my attention to the species *in Mr. Wilson's collection*, under the general title of "*Leuconia*," and leave others to divide them into genera hereafter when a complete history of the calcareous sponges shall be produced.

Since describing the last of the Ascones ('Annals,' 1886, vol. xvii. p. 512), viz. *Clathrina ventricosa*, wherein the amount of parenchyma far exceeds that observed in any of the Sycones, as before stated (*suprà*, p. 35), this structure has not presented itself to anything like the extent of that characterizing the sponges about to be noticed, although the excretory canal-system may be easily homologized throughout. Hence the following diagnosis under the "heading" before mentioned, viz.:—

Leuconia.

Calcareous sponges in which the parenchyma is almost equal in amount to the excretory canal-system, which traverses it in all directions by repeated subdivision, until one is as infinitely divided as the other. Canals poriferous throughout.

28. *Leuconia fistulosa*, var. *australiensis*.

Individualized. Specimen long, straight, sacciform, and so flatly compressed that the sides are in close approximation; suddenly contracted at the free end to 6-16ths inch, while the rest of the body generally is 10-12ths inch in diameter; provided with a peristome (whose spicules are broken off so shortly that the mouth looks as if it were *naked*); convex at the large end, where it was attached by the most prominent part to the object on which it grew. Colour sponge-brown. Surface consisting of cribriform sarcode charged with sagittal triradiates and densely traversed by more or less long flimsy acerates, arranged in thin, broken, indistinct lines, apparently without any uniformity. Pores, which are the holes of the cribriform sarcode, comparatively small in size. Vent single, terminal, occupying the free end of the specimen, which is truncate, compressed to a narrow slit; surrounded by a peristome; leading into a large cloacal cavity corresponding in shape with that of the body, which is slightly contracted in the centre; scattered over with holes of different sizes and different distances apart, some very large and deeply sunk into the internal structure, others very small and shallow, all showing *inwardly* a variable number of openings, which belong to the excretory canals of the wall-structure; surface of the cloaca, its holes and deep depressions, all echinated with the short and curved fourth ray of quadriradiates. Structure of the wall, which, compared with the width of the cloaca, is very thin (not being more than 3-24ths inch in diameter), composed of cancellated sarcode traversed by the canals of the excretory canal-system, which, repeatedly branching, subdivide the whole almost infinitely: supported on small triradiates, which appear to have no definite arrangement. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of different lengths and different sizes, the longest and finest chiefly confined to the peristome (but for the most part broken off, so that their original length cannot be ascertained); some, viz. the stoutest, which remain entire, fusiform, bent at the extremity, and much shorter than the rest, averaging 150 by 12-6000ths inch. 2, triradiates, regular and irregular, of different sizes and forms, chiefly sagittal. 3, quadriradiates, of much the same size, which is rather small. No. 1 in its finest and longest forms chiefly characterizes the peristome, but is equally spread all over the body together with the shorter and stouter ones, all mixed up in a matted more or less shaggy mass, so that when dry the whole surface glistens from the silky flimsy nature of

the *fine* spicules; no. 2 equally present in the wall-structure and its outer and inner layers, viz. that of the surface and that of the cloaca respectively; no. 3 is chiefly confined to the cloaca, where its fourth ray, which is short and curved, thickly echinates not only the general surface of this cavity, but the circular margins of the holes and the surface of the canals within them respectively. Size of specimen $3\frac{1}{2}$ inches long by 10-12ths inch in its widest diameter.

Obs. One cannot help seeing in this specimen the Australian representative of the British *Leuconia fistulosa*, Bk.,= *Grantia fistulosa*, Johnston, of which the type specimen is in the British Museum; nor can we help seeing in the excretory canal-system a close approach to that of the non-calcareous sponges.

29. *Leuconia hispida.*

Individualized. Erect, conoglobular, compressed, contracted towards the base, peristomed. Colour whitish yellow on the outside, sponge-brown within. Surface thickly echinated with comparatively thin fusiform acerates, held together rather confusedly in indistinct groups by cribriform sarcode, which in the intervals often presents defined areas. Pores, viz. the holes of the cribriform sarcode, of different sizes, varying under 1-451st in. in diameter. Vent single, circular, terminal, on the summit, provided with a peristome about 1-16th in. in diameter, leading into the cloacal cavity, which becomes three times as wide, corresponding in form with that of the specimen; holes in the cloaca very variable in size and distance apart, the latter depending on the width of the cloaca-skeletal structure between them; presenting *within* their border from one to four or more circular openings, which belong to the excretory canals of the internal structure; thus every hole in the cloacal surface is tantamount to that of a subcloacal vent; surface of the cloaca and margins of the holes respectively thickly echinated with the long curved fourth arms of quadriradiates. Structure of the wall, which is thick, cancellated, traversed by the canals of the excretory system, supported skeletally on smallish triradiates. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. one long, thin, straight, cylindrical, silky, and the other slightly curved, stouter, and fusiform, the latter averaging 200 by 4-6000ths in.; 2, triradiates, all apparently about the same size, which is comparatively small, regular and irregular, with the arms in different degrees of sagittal expansion; 3, quadriradiates, numerous. No. 1,

in its thin form, is confined to the peristome, and in its stouter one to the surface, where it is indistinctly grouped into tufts between the cribriform areas; no. 2 to the structure of the wall generally; and no. 3, the quadriradiates, to the surface of the cloaca, where its fourth arm, which is long and curved, thickly echinates the surface. Size of specimen 7-12ths inch high, not including the peristome, by 5-12ths inch in its greatest transverse diameter, being rather compressed.

Obs. This species is closely allied to *Leuconia fistulosa*, var. *australiensis*, in most respects.

30. *Leuconia echinata.*

Individualized and social. Pyriform, wide above, narrow below, where it is contracted and turned on one side towards the point of attachment; peristomed; thickly echinated with large, much curved acerates. Colour whitish yellow outside, sponge-brown within. Surface composed of cribriform sarcode in the midst of small radiates; echinated with the acerates mentioned. Pores, the holes in the cribriform sarcode, most of which are comparatively small, while the rest, scattered here and there, vary under 1-166th inch in diameter. Vent single, circular, terminal, surrounded by a peristome, leading into a sacciform cloacal cavity corresponding in shape to that of the specimen, a little wider in its widest part than the thickness of the wall; holes in the cloaca subcircular, large and wide apart, each sphinctered by cribriform sarcode, whose interstices are circular and in more or less plurality, varying in diameter under half that of the subjacent hole; surface of the cloaca moderately covered with thick curved spines, viz. the fourth arms of quadriradiates. Structure of the wall cancellous, supported on the rays of large triradiates, and traversed by the canals of the excretory system. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. one long, straight, thin, cylindrical, silky, and the other thick, fusiform, much curved, and very thick, the latter averaging 450 by 18-6000ths in.; 2, triradiates of different sizes and different degrees of irregularity, the smallest and most regular on the surface, the next in size on the surface of the cloaca, and by far the largest of all, whose shaft may be 102 by 18-6000ths and arms respectively 150 by 18-6000ths, confined to the wall-structure; 3, quadriradiates, in which the fourth arm is thick and curved. No. 1 is confined to the peristome in its fine straight form, and in its curved and stout one thickly echinates the surface, where its outer part, which is the largest and most curved, is directed

towards the mouth and its inner one directed backwards, to become sunk into the structure of the wall; no. 2, the tri-radiates, are disposed as before mentioned; and no. 3 is chiefly confined to the surface of the cloaca, where its fourth arm, which is thick, moderately long, and curved towards the mouth, plentifully echinates the surface of this cavity. Size of specimen about $\frac{1}{2}$ inch high by $\frac{1}{3}$ inch in its widest part.

Obs. The spiculation in this small pear-shaped species generally is, with the exception of the radiates in the surface, comparatively large, and the cribrated sarcode stretched across the holes of the cloaca, although unusual in the calcareous sponges, is not uncommon at the vents of the *non*-calcareous ones. In one small specimen, for there are several of different sizes, the peristome is as long as the body of the sponge itself, which is 3-24ths inch, showing that the matured size of the spicules may be independent of that of the sponge.

The next form to be described is very much like this, but, in addition to the large curved acerates of the surface, possesses *cones or conical spines* formed of a great number of fine spicules like those of the peristome interspersed between them.

31. *Leuconia erinaceus.*

Individualized and social. Specimen pyriform, sack-like, wide above, where it is furnished with a peristome, narrowed to the point of attachment below. Colour whitish yellow outside, sponge-brown within. Surface-sarcode cribriform or reticulate, knitting together the radiates of this part, which are small; echinated with two kinds of spines, viz. one conical, composed of a great number of fine, long, glistening spicules like those of the peristome, and the other consisting of a single, thick, sickle-shaped acerate, interspersed among the glistening white cones. Pores the holes of the cribriform sarcode. Vent single, terminal, circular, provided with a well-marked sarcodic sphincter, surrounded by the palisading of the peristome, which is somewhat everted; leading into a narrow cloacal cavity about half the width of the wall in its greatest diameter, which part is opposite the greatest diameter of the specimen, diminishing afterwards towards either end; covered with a sarcodic membrane presenting circular holes which are opposite those of the cloaca; holes of the latter wide and circular, but variable in size and distance apart, permitting the terminal openings of the canal-system in plurality to be seen *within*. Wall consisting of cancellated sarcode traversed by the canals of the excretory system; supported on a skeletal structure consisting of regular and

irregular triradiates with long shafts, especially on the outside, where they extend inwards from the other two arms which are fixed in the spicular structure of the surface. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one fine, long, straight, cylindrical, and glistening, and the other stout, much shorter, fusiform, and sickle-shaped; 2, triradiates, regular and irregular, with long shafts but not particularly large. No. 1 in its fine form is confined to the peristome and the composition of the conical spines of the surface, which are about 200-6000ths long, 300-6000ths apart, and 90-6000ths in. in diameter at the base, where their spicules are sunk into the outer part of the wall; and the other or stout form, which consists of a *thick acerate* that is much shorter than the "cones" and curved towards the mouth, plentifully scattered among them, where its largest portion is outside and the other or more attenuated one is sunk into the outer portion of the wall-structure; no. 2, the triradiates, occupy the position mentioned, including the surface of the cloaca, which possesses *no* quadriradiates, and therefore presents *no* spines or "fourth arms" on its surface. Size of largest specimen, for there are several, about $\frac{1}{2}$ inch high by $\frac{1}{4}$ inch in its greatest diameter.

Obs. This is a very remarkable species on account of the glistening cones, composed of spicules like those of the peristome, which are scattered over the surface in the midst of large sickle-shaped acerates which do not glisten, and therefore by their colour, as well as by their form, produce a mixture and a contrast which renders this sponge unmistakable; while the cones from their prominence, whiteness, large size, pointed ends, abundance, and almost perpendicular arrangement on the surface so remind one of the echination of a "hedgehog," that the latin name of this animal has been used for its specification. The cloaca here also is covered with a delicate layer of clathrous sarcode.

32. *Leuconia nivea*, var. *australiensis.*

Individualized or agglomerated. Globular, sessile, and solitary, or massive, agglomerated, flat, and spreading. Colour whitish outside, sponge-brown within. Surface consisting of cribriform sarcode, more or less charged with mortar-spicules, knitting together large, more or less sagittal triradiates, with centre so much *elevated* that they present a tripod-form, whose extended arms thus bind down the surface to a common level. Pores, the holes of the cribriform structure more or less grouped into distinct areas, which occupy the intervals between

the arms of the triradiates. Vent single and terminal in the individualized solitary forms, in plurality in the flat ones, in which they are more or less uniformly scattered over the surface in a papillated state, about $\frac{1}{6}$ inch apart, each furnished with a minute peristome, which consists of *mortar-spicules* like those that fringe the pores of the dermal cribriform sarcode; leading in the globular forms into a regularly formed cloaca corresponding in shape with the specimen, and into irregularly branched canals in the flat ones; holes of the cloaca of different sizes and different distances apart, the largest more or less sunk into the internal structure, and all affording outlets to a variable number of excretory canals; surface of the cloaca, together with that of the holes and their subsequent extensions respectively into the internal structures, thickly echinated with small spines, viz. the fourth arms of the quadriradiates. Wall composed of cancellated structure, that is the parenchyma, traversed by the canals of the excretory system, supported on a skeletal structure composed of small triradiates. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, minute, sinuous, and lanceolate at one end, about 14 by $\frac{1}{2}$-6000th in.; 2, triradiates, of two sizes, viz. those of the wall-structure, which are small and more or less regular, and those of the surface, which are large, averaging 105 by 9-6000ths in. in the shaft, with arms respectively a little less; 3, quadriradiates, with long expanded arms and very short spine or fourth ray. No. 1 is confined to the cribriform sarcode of the surface and to the peristome, where in the former it acts as a mortar-spicule; no. 2 chiefly to the structure of the wall and the surface respectively, as before stated; and no. 3 to the surface of the cloaca, where the spines or fourth rays are so small and short that they can only be seen laterally. Size of globular form about 4-12ths inch high and 3-12ths inch in diameter horizontally; the flat form is merely a fragment about an inch in diameter and 1-24th inch thick.

Obs. With the exception of trifling differences, the Australian species in its *flat* form is almost identical with the British one called *Leuconia nivea*, Bk. (*Leucandra nivea*, H., Atlas, Taf. xxxix.)—that is, there are no quadriradiates like those represented by Bowerbank (Mon. vol. iii. pl. v. fig. 8), and the elements of the surface in *L. nivea* appear to be much more confused and indistinct, while they are beautifully defined in the Australian form; but in other respects the latter appears to be so nearly allied to the British one that it can hardly be considered more than a variety of it.

33. *Leuconia Johnstonii*, var. *australiensis.*

Individualized. Globoconical, sessile, rather compressed, open and conical above, convex and wide below, where the most prominent part becomes the point of attachment; no peristome. Colour whitish outside, sponge-brown within. Surface consisting of cribriform sarcode charged with triradiates, faced by comparatively large quadriradiates. Pores, the holes of the cribriform sarcode, varying in size under 1-200th inch (? are the largest for *ex*halant purposes). Vent single, terminal, naked, leading into a sacciform cylindrical cloaca, corresponding in shape with that of the specimen, about the same diameter in its widest part as the thickness of the wall; scantily overscattered with a few holes of widely different sizes, viz. some very large (1-24th inch in diameter) and others very small, situated at variable distances apart, and the large ones so sunk into the internal structure that they appear like diverticula of the cloaca, into which more or less of the excretory canals of the internal structure open, and thus pour out their contents before the latter enter the cavity of the cloaca itself; surface of the cloaca, together with its diverticula, entirely smooth and void of all echination, being bound down by sagittal triradiates *only*. Wall comparatively thick, consisting of cancellated sarcodic structure traversed by the canals of the excretory system, supported by a skeletal structure composed of triradiates and quadriradiates of different sizes, among which the sagittal form is most conspicuous. Spicules of two kinds, viz. triradiate and quadriradiate:—1, triradiates, of different sizes, chiefly irregular, among which the sagittal is, as just stated, the most conspicuous; 2, quadriradiates, of different sizes, which are again mostly sagittal, that of the surface, which is by far the largest, averaging 135 by 12-6000ths in. in the shaft and a little less in the arms, so that it has an *equiarmed* appearance; the arms arching upwards and outwards serve to bind down the dermal structure, and the shaft descending perpendicularly to support it from within; while thus traversing the outer part of the wall the shafts are accompanied by dilated portions in their intervals which are identical in appearance with the "subdermal cavities" of the non-calcareous sponges. No. 1 is abundant in the skeletal structure of the wall and in its limiting layers, viz. that of the surface or cortex and that of the cloaca; no. 2, the quadriradiate, is equally abundant with the triradiates in the structure of the wall, and almost exclusively on the surface of the body, but *entirely absent* on that of the cloaca, on which a curved spine or fourth arm is not to

be seen. Size of largest specimen, viz. that described (the other, which is very small, being just the opposite in point of general form), about ½ inch high by 5-12ths inch in its greatest diameter.

Obs. It is remarkable here that while the quadriradiates abound on the surface and are so large as to form a character, their *absence* is equally characteristic on the surface of the cloaca. To facilitate recognition of the *quadriradiate* on the surface it might be observed, as in the preliminary remarks, that the passage of the light *through* the centre of the head or triradiate portion invariably causes that part to present a dark *triangular* space, whose points are in the angles of the rays; while when the *triradiate* is in such a position as to show a dark area (that is when viewed laterally), this is *quadrangular*. At first sight the presence of the large quadriradiate on the *surface* causes this species to resemble the British *Leuconia Johnstonii*; but the peculiar form of the quadriradiate and its fourth arm on the cloaca of the latter, together with other minor differences, causes it to be merely a variety.

34. *Aphroceras asconoides.*

Individualized and social. Specimen consisting of a group of individuals growing from a contracted base. Individual long, narrow, tubular, sessile, somewhat compressed, diminishing in size towards the free end, which is truncate, and contracted towards the other, which is fixed; without peristome; varying in size under 1½ inch long by 3-24ths inch in transverse diameter, often putting forth a bud or small branch towards the lower part. Colour yellowish white. Surface even, glistening when dry, composed of a layer of long, slightly curved acerates, arranged longitudinally and very near together, separated only by cribriform sarcode, traversed so thickly by the *exserted* arms of *internal* radiates as to present a minutely hispid appearance. Pores, the holes in the cribriform sarcode, opening between the long acerate spicules, and in the midst of the exserted arms of the internal radiates. Vent single, terminal, naked, leading into a cloacal cavity which is tubular, corresponding with the shape of the individual; presenting *no* cloacal structure, but a number of minute circular pores in direct continuation with those of the surface, in the midst of a layer of spongozoa in juxtaposition, with which that remarkable granuliferous nucleated body called by Häckel the "Kern" (to which I have already alluded in describing *Clathrina cavata*, 'Annals,' 1886, vol. xvii. p. 502) is plentifully mixed; supported on a skeletal structure composed

of comparatively small and delicate sagittal quadriradiates, which will be more particularly described hereafter. Wall very thin, not more than 1-112th inch in diameter, consisting of only two skeletal layers, viz. an external and an internal one, the former composed of the large slightly curved acerates before mentioned, and the latter of the delicate quadriradiates just noticed, which support the soft parts of the species. Spicules of two kinds, viz. acerate and quadriradiate:—1, acerates, very large, long, symmetrically fusiform, slightly curved, sharp-pointed at each end, averaging 1-12th inch long and 25-6000ths in. in transverse diameter; 2, quadriradiates, more or less sagittal in form, with a long shaft directed longitudinally backwards when *in situ*, and the two arms expanded laterally almost perpendicular to the shaft, with the fourth arm, which is short and curved towards the mouth, directed inwardly; shaft about 90 by 1-6000th in., arm 43 by 1-6000th. No. 1 forms a single layer on the surface as before stated, and no. 2 the internal layer also before noticed, with more or less of the arms exserted between the long acerates, so as to give this part a minutely hispid appearance. At first sight the latter look like mortar-spicules or small acerates, but although they appear to serve the same purpose, they are *not* so, but what I have stated. Size of group about 2 inches in diameter at the circumference, contracted to a point at the base.

Obs. In *structure* this species is very like Häckel's *Asculmis armata* ('Atlas,' Taf. xiii. fig. 1), but of course very different otherwise. It is remarkable too that the "granuliferous nucleated cell" or "Kern" which is so characteristically abundant in the Ascones (ex. gr. *Clathrina*) should be equally abundant here.

35. *Aphroceras syconoides.*

Individualized. Long, sessile, round, cylindrical, diminishing towards the mouth, which is truncate, also towards the fixed end, which is contracted; without peristome. Colour in the dried state whitish grey. Surface consisting of cribriform sarcode, charged with mortar-spicules, more or less concealing subjacent, large, slightly curved, fusiform acerates, arranged longitudinally, parallelly, and in close approximation. Pores in lines, in the cribriform sarcode between the long acerates. Vent single, terminal, naked, leading into a cloacal cavity which is narrow and accords in shape with that of the specimen; covered with circular sphinctered holes in juxtaposition and of nearly uniform size; echinated with the

fourth arm of quadriradiates, which is small, curved, and short. Wall about 1-30th inch thick, composed of "*radial chambers*" in juxtaposition, extending from the circular pores on the surface to the holes of the cloaca; supported by a skeletal framework consisting of a great number of small radiates, that is "articulated;" the whole held together by sarcode pierced by pores of intercommunication. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. one very large, long, symmetrically fusiform, slightly curved and pointed at each end, about 150 by 6-6000ths in., and the other minute, somewhat sinuous and lance-pointed at one end, 13 by 1-6000th in; 2, triradiates, more or less sagittal and comparatively small, averaging about 48 by 2-6000ths in. in the shaft and 15 by 2-6000ths in. in the arms respectively; 3, quadriradiates, with the fourth arm, as usual, much shorter than the rest, and curved towards the mouth. No. 1 in its large form is confined to a single layer on the surface, where they are arranged longitudinally parallel to each other and closely approximated, and in the minute form to the cribriform sarcode of the surface, wherein it plays the part of a mortar-spicule; no. 2, the triradiates, to the radial chambers, where their heads are inwards and their shafts directed outwards; and no. 3, the quadriradiates, which are also sagittal, to the surface of the cloaca, where the fourth arm is so short that, to be well seen *in situ*, this surface must be viewed under the microscope *laterally*. Size of specimen $\frac{3}{4}$ inch high by 7-48ths in its greatest horizontal diameter.

Obs. In general form and structure this species is very much like Schmidt's *Ute glabra* (Adriat. Spong. 1 Suppl. p. 23, Taf. iii. fig. 1), but the fourth arm of the quadriradiate is much less developed; and from Häckel's spiculation ('Atlas,' Taf. lvi. figs. 1 *a*–1 *t*) there does not appear to have been any "mortar-spicule." Again, had it been identical with the Australian species, the beauty and striking appearance of the pores on the surface in the latter (which, for the most part, are conspicuously situated in lines between the large acerates, very little less in size than the holes of the cloaca, and each terminating the external end of a radial chamber) would hardly have passed unnoticed, so that it may be assumed that, if not a variety, it must be considered a species of *Ute*. At the same time it may be as well to consider whether the species should be called "*Ute*" or "*Aphroceras*."

In 1858 Dr. J. E. Gray described and illustrated a small, branched calcareous sponge from Hongkong under the name of "*Aphroceras alcicornis*" (Proc. Zool. Soc. 1858, p. 113, pl. x.

figs. 1 and 2), of which he subsequently made a family under the name of "Aphrocerasidæ" (*ib.* 1867, p. 558); meanwhile Dr. Bowerbank described a British species under the name of "*Leucogypsia Gossei*," for which he established the genus "*Leucogypsia*" (Phil. Trans. 1862, p. 1095, pl. lxxii. figs. 3 and 4); and, lastly, Häckel in 1870 called these species respectively "*Leucandra alcicornis*" and "*L. Gossei*," which he placed in the genus *Leucandra* of his family Leucones.

Now an examination of *Aphroceras alcicornis* and *Leucogypsia Gossei* shows that they are almost identical in structure and spiculation, although very different in form; thus they, in their aggregate state, may have a plurality of vents which are all *un*peristomed, each of which may lead into a separate narrow cloaca, which may be once or twice locularly divided, and each loculus indistinctly limited by further dividing into several large canals, thus forming a step towards a simple, branched, canalicular structure without distinct cloaca, as will be found by-and-by in *Teichonella prolifera*; while the structure in which these cloacas are situated consists of cancellated sarcode permeated by the canals of the excretory system, and supported on a spicular skeleton consisting of small radiates, traversed longitudinally by large, long, fusiform, slightly curved, symmetrical acerates, more or less pointed at each end, arranged longitudinally and parallel to each other *throughout* the structure of the wall, but generally most abundant towards the surface*.

Of the fact that both of these species have been placed by Häckel in his family of Leucones there can be no doubt; nor can there be any that Dr. Gray's name, in the matter of nomenclatural priority, takes precedence of all others.

On the other hand, to Schmidt's "*Ute glabra*," which was described in 1864 (*l. c.*), Häckel, in 1870, gave the name of *Sycandra glabra*, and placed it under the genus *Sycandra* in his family of Sycones.

Thus my *Aphroceras asconoides* and *A. syconoides* (which latter is but a variety of Schmidt's *Ute glabra*), together with *Aphroceras alcicornis*, Gray, would, if relegated according to the *structure of their walls*, come under Häckel's families of Ascones, Sycones, and Leucones respectively; but if relegated according to the *striking character of their spiculation* which the large parallel accrates present, *all* would come under the

* Mr. Thomas H. Higgin, F.L.S., of Liverpool, in 1874, found a *branched* species of *Aphroceras* at Holyhead, which I have described under the name of *A. ramosa* (see Report 1 of the Liverpool Marine Biological Committee upon the "Fauna of Liverpool Bay and the Neighbouring Seas," p. 92, ed. Prof. W. A. Herdman, D.Sc. &c. 1886).

family for which Dr. Gray has proposed the name of "Aphrocerasidæ," and which Häckel has placed among his Leucones, as above stated.

Are we, then, to distribute these species according to the structure of the wall or according to their peculiar spiculation? for "peculiar" it is, since the acerate form that I have described is not, to my knowledge, to be found in any other calcareous sponges but the "Aphrocerasidæ." I must leave this for future observation to decide, while for the present their descriptions may remain where they are.

It is possible that here and there one of the large acerates may have a lanciform end or vary a little in its symmetrical form; but these are accidental occurrences.

Here I might add that, as this form of acerate spicule is identical with one which is very common among the *non*-calcareous sponges, and the "Aphrocerasidæ" are the only ones in which it occurs among the calcareous sponges of the present day, so it may be assumed, in a fossil point of view, as Zittel has done, that a calcareous sponge did exist in the Cretaceous age, in which the only spicules were of this form, that is without radiates; and hence Zittel has instituted for his third family of fossil calcareous sponges the name of "Pharetrones," which, until this assumption can be proved, must remain, as Prof. Sollas has described and illustrated it, under the name of *Pharetrospongia Strahani*, among the *non*-calcareous sponges, or those possessing *siliceous* spicules of this form alone (Quart. Journ. Geol. Soc. 1877, vol. xxxiii. p. 242 &c. pl. xi.).

The next species that will be described, as hitherto it has only been named, is of the same type as *Aphroceras*, but possesses a form of the triradiate spicule which is so peculiar that it has been actually identified with one in a fossil calcareous sponge of Jurassic age, and is therefore also of much palæontological interest. It is that to which I have alluded in my preliminary remarks under the name of *Lelapia australis* ('Annals,' 1886, vol. xvii. p. 440).

36. *Lelapia australis*, Gray.

Lelapia australis, Gray, Proc. Zool. Soc. 1867, p. 557.

Individualized. Cylindrical, with enlarged free end bent upon itself and elongated transversely, hammer-like. Colour whitish yellow. Surface even, presenting a number of large long acerates like those of the foregoing species, imbedded longitudinally at variable distances apart, being more or less obscured

superficially by the presence of a dermal layer of small acerates and mortar-spicules. Pores indiscriminately scattered over the surface. Vent single, at one end of the transversely elongated head, which is more acuminated than the other, where it is furnished with a short glistening peristome, leading into a cloaca that extends in a cylindrical form, increasing in size from the base to the head, where, corresponding with the hammer-like form of this part, it divides into two portions, one of which leads to the closed, and the other to the open end; surface of the cloaca presenting throughout several subcircular holes of different sizes and distances apart, each of which is furnished with a sphinctral diaphragm of sarcode, and the whole sparsely echinated with the fourth arms of quadriradiates, which are very short. Wall composed of cancellated canaliferous sarcode, like that of the genus *Heteropia*, traversed in its *entirety* longitudinally and abundantly by the large acerate spicules at various distances apart, which are crossed perpendicularly *at intervals* by bundles of small thin tricurvates which possess the peculiar form that will be mentioned hereafter, and extend from the surface on one side to the cloaca on the other. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, consisting of those which belong to the peristome, the body, and the surface respectively; 2, triradiates, divided into those which belong to the surface and the cloaca respectively; and 3, quadriradiates, which appear to be very few in number on the cloaca, confined to the surface of the latter and that of the body. Acerate of the peristome long, straight, cylindrical, thin, glistening, sharp-pointed at each end, averaging 300 by 1½-6000th in.; that of the body, including the wall and the surface or cortex, also long but thick, almost equally fusiform, slightly curved and more or less sharp-pointed at each end, averaging 330 by 18-6000ths in., and that of the surface minute, straight, and lance-pointed at one end, in short the "mortar-spicule;" all three forms equally abundant in their several localities. Triradiates of various forms and sizes, according to their position, viz. those on the surface small and those in the cloaca large, the latter sagittal with very long and almost straight arms expanded perpendicularly to the shaft, which is very short and straight, apparently reduced in size inversely to that of the arms, the latter becoming *flattened vertically* towards the commencement or proximal end of the peristome, where, by extending perpendicularly across its spicules while the reduced shaft is directed as perpendicularly backwards, they act, as before stated, in securing the position of this palisading like the cross bars of a row of pales. Quadri-

radiates small on the surface, where they are mixed up with the mortar-spicules &c., and scanty on the cloaca, where in their triradiate portions they accord in size and form with the sagittal triradiates of the latter, but with the addition of the fourth arm, which is comparatively short and scantily echinates the interior of the cavity. With reference to that peculiar form of triradiates, whose position has before been stated, and which is of so much palæontological interest here, it may be observed that it is two-pronged fork-like, in which two of the arms are projected forwards parallel to each other and closely approximated, while the third or shaft is prolonged backwards in the opposite direction, altogether resembling a "tuning-fork," in which the arms are smooth, round, and pointed, about 60 by 1-6000th in. in their greatest dimensions, with one arm a little longer than the other, while the shaft, which may be a little longer and double the thickness, is smooth, round, and also pointed, about 75 by 2-6000ths. In their natural position they lie parallel to each other, with their shafts *outwards* and their forks directed towards the cloaca in bundles "at intervals," as before stated, while it should be added that there are *no* other spicules in the skeletal structure of the wall but the large long acerates and these crossing bundles, hence the clathrous structure of the simple sarcode becomes very evident, simulating that of the genus *Heteropia* rather than that of a *Leuconia*, which, on the contrary, is charged with radiates throughout and thus thickened. They are also to be found among the peristome-spicules towards their lower part. Size of specimen $\frac{3}{4}$ in. high by $\frac{1}{4}$ in. in diameter horizontally; breadth of head transversely about $\frac{1}{2}$ in.

Obs. It is impossible to compare the above description with that of Häckel's *Leucortis pulvinar* ('Kalkschwämme,' vol. ii. pp. 164–166) without seeing that the two are closely allied, and that, but for the absence of the quadriradiate, the minute acerates or "mortar-spicules," and the peristome in his illustrations (Taf. 29), one would have been inclined to say it was the same. The "peristome-spicule," however, is mentioned in the description, but the shape of the large thick body-acerates being *sinuous* (*cf.* illustrations), instead of simply curved, is not the same; so that altogether it is necessary to give our species a different designation; and as this has been done by Dr. Gray both generically and specifically for the original two-pronged fork-like spicules figured by Dr. Bowerbank, which also came from S.W. Australia, as noticed in my preliminary remarks (*l. c.*), we may fairly assume that they came from this species, and so I have

adopted Dr. Gray's name. Häckel's "connective variety," viz. *Leucandra pulvinar* (p. 164), is said to present the quadriradiate; but as no other part of the spiculation is mentioned, we must assume here that it was the same as that of his typical species "*Leucortis pulvinar.*"

I have already alluded to the fork-like spicule as being interesting, because it has been discovered in a fossilized Calcisponge from the "Cretaceous" (*l. c.*); but the largest and most perfect that I could find in the mounted slice of *Sestrostomella rugosa*, in which it was first noticed by Dr. Hinde, who kindly lent it to me for examination, is not quite half so large as the largest that I have been able to see in *Lelapia australis*, added to which the shaft was lanceolate at the end in the fossil as in that of *Leucetta pandora*, represented by Häckel (Taf. xxiii. &c.), and not simply pointed like all those that I have seen in *Lelapia australis*; but we know that position may influence these trifling differences, and even those two figured by Dr. Bowerbank (*op. et loc. cit.*) are not alike in this respect, the shaft in one being simply pointed and in the other inflated before the end or lanceolate.

It is remarkable too that the two arms *without* the shaft should bear considerable resemblance to the forcipitous flesh-spicule in the genus *Forcepia* among the siliceous sponges (*Halichondria forcepis*, Bk., Mon. B. Sp. vol. iii. pl. xliii. fig. 13), wherein also the arms are long, parallelly approximated, and of *unequal* length. In one it is the arms of a triradiate and in the other a bent acerate.

Observation.

We have now come to species of *Leuconia* in which the typical form of the "cloaca" no longer exists, and this was initiated by the division and indistinctly circumscribed condition of these cavities in *Aphroceras alcicornis* and *Leucogypsia Gossei*; there is no longer any peristome, and both this and the cloaca in the following species will at last be found to disappear altogether, when the excretory canals, which hitherto have ended in a cloacal dilatation and peristomed vent, will be found to open directly on the surface without the intervention of either.

37. *Leuconia multifida.*

Agglomerated. Specimen sessile, massive, compressed, irregularly undulating on the margin, which is thus divided into five more or less conical and projecting portions, each provided with a mouth, but *no* peristome. Colour whitish

yellow outside, sponge-brown within. Surface consisting of lace-like cribriform sarcode charged with mortar-spicules, and knitting together tolerably large triradiates, that is wide with thinnish arms, more or less uniform in size. Pores, the holes in the cribriform structure, averaging 1-400th in. in diameter, mixed with larger ones four times the size, which often appear to have been produced by disruption of the sarcodic partitions between the smaller ones. Vents single, terminal, naked, one upon each conical projection, each leading into a cloaca, which is narrow, ending in a general one that is broad, irregular, and compressed like the specimen; holes of the cloaca circular, irregular in size and distance apart, leading inwardly to one or more openings which belong to the excretory canals of the internal structure. Walls as indistinctly defined internally as the cloacal cavity is irregular, and, owing to the compressed form of the specimen, presenting a greater thickness of the cancellated structure in one direction than the other, so that, for want of definition, it *can* only be considered "wall" in name; cancellated structure consisting of parenchyma traversed by the canals of the excretory system, supported by a spicular structure which is composed of radiates of different sizes, but mostly large, irregularly distributed, and so far apart as to cause the sarcodic portion just under the cribriform structure of the surface to present dilatations similar to the subdermal cavities of the non-calcareous sponges. Spicules of two kinds, viz. acerate and triradiate:—1, acerate, minute, sinuous, with one end lance-pointed, averaging 15 by $\frac{1}{2}$-6000th in.; 2, triradiates, regular and irregular, of different sizes, averaging 117 by 8-6000ths. No. 1 is confined to the cribriform sarcode of the surface, where it forms the mortar-spicule; no. 2, the triradiates, about the same size, both on the surface and in the wall structure, only a little stouter in the latter; thinnest on the surface of the cloaca, where, as usual, they present long, expanded arms and short shafts respectively. Size of specimen $\frac{1}{2}$ in. high by 10-12ths $\times$ 3-12ths horizontally.

Obs. There is nothing very striking in this species to distinguish it from the following except the absence of quadriradiates and the larger size of the staple spiculation, that is the spiculation of the parenchyma, which, of course, renders this structure less compact than where the spicules are smaller and more numerous. It is charged with ova about 13-6000ths in. in diameter, bearing the germinal vesicle and accompanied as usual by granuliferous cells about 4-6000ths in. in diameter, which may be spermatic—easily recognized as the spongozoa are not half this size—measurements which

could not have been made had not the specimen been in a favourable state for such observations.

The words "large" and "small," tolerable" and "moderate," &c., with reference to the size of the spicules, have been used for convenience; but they are all indefinite terms, which are only rendered satisfactory when accompanied by actual measurements. Still, it should be remembered that when they are used the magnifying-power should be the same for all, otherwise what is small at one time may appear large at another, and *vice versâ*.

38. *Leuconia lobata.*

Specimen massive, sessile, lobate, presenting two or more apertures of unequal size, not peristomed. Colour whitish yellow. Surface even, compact, chiefly consisting of mortar-spicules and small radiates, interspersed here and there with a large one which belongs to the internal structure. Pores not conspicuous. Vents two or more, naked, of different sizes, leading into a single, irregular, and indistinctly defined cloacal cavity, whose surface is scattered over with holes of different sizes, more or less sunk into the internal structure and in direct continuation with the large ends of the canals of the excretory system; echinated throughout with the fourth arm of sagittal quadriradiates, which is minute. Internal structure cancellous, traversed by the canals of the excretory system, which end in the diverticula of the cloaca already mentioned. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, minute, sinuous, lance-pointed at one end, about 13 by $\frac{1}{2}$-6000th in.; 2, triradiates of two sizes, viz. small and large, the rays of the latter generally averaging 105 by 9-6000ths in.; 3, quadriradiates of three sizes, the largest of which is of much the same size as the larger triradiates. No. 1, which is confined to the surface, is the "mortar-spicule;" no. 2, the triradiate, in its small size is confined to the surface, where it is mixed up with the mortar-spicule, and in its larger one to the structure of the interior, extending here and there also to the surface; no. 3, the quadriradiates in their smallest size are mixed up with the triradiates and mortar-spicules of the surface, in their largest size they belong to the parenchyma, where they are mixed up with the triradiates of this structure, and in their thin sagittal form to the surface of the cloaca, where, as usual, the arms are very long, almost straight, and expanded perpendicularly to the shaft, which is comparatively short and straight, averaging 16 by 3-6000ths, while the arms average 60 by 4-6000ths; the fourth arm, which is shorter still, not only echinating the

surface of the cloaca, but also extending into the canals of the internal structure. Size of specimen $\frac{3}{4}$ in. in height by 1 in. in diameter.

Obs. The compactness and consequent whiteness of the structure in this species contrasts strongly with that of *Leuconia multifida*, if the presence of the quadriradiates did not absolutely make the distinction.

39. *Leuconia compacta.*

Specimen massive, sessile, lobate, lobes round, furnished with a plurality of small naked vents, growing on and enveloping the small stems of a Fucus. Colour whitish, opaque. Surface even, consisting of cribriform sarcode cementing together into compact structure small, more or less regular triradiate and quadriradiate spicules of uniform size and appearance, thickly echinated with very large and much curved acerates. Pores, the holes in the cribriform structure, uniformly small, about 3 to 6-6000ths in. in diameter. Vents in plurality, of different sizes, scattered irregularly over the surface, the largest on the most prominent parts of the lobes respectively; all without peristome, that is naked, leading into narrow, irregularly defined, cloacal cavities, which branch off into the substance of the body or parenchyma, where they become almost infinitely subdivided; surface of the cloacal cavities, together with the canals entering them, slightly echinated with the fourth arm of quadriradiates. Structure of the wall, or rather body as it may be termed (for these distinctions *now* begin to disappear), compact, consisting of parenchyma infinitely divided by the branching and rebranching of the excretory canal-system, as just mentioned; supported on a skeletal structure consisting of small triradiates and quadriradiates like those of the surface. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, large, stout, unsymmetrically fusiform, much curved, averaging 180 by 21-6000ths; 2, triradiates, regular and irregular, uniformly small, arms averaging 30 by $4\frac{1}{2}$-6000ths; 3, quadriradiates, about the same size, but with the fourth arm, as usual, much shorter than the rest. No. 1 thickly echinates the surface, where the thicker half, which is much curved, is free, and the thinner one is sunk into the substance of the body, with whose spicular structure in size also it forms a great contrast, as may be learned from the measurements above given of the acerates and radiates respectively; nos. 2 and 3 are uniformly distributed throughout the body, in which the surface of the cloacal dilatations and the large canals respectively are sparsely echinated with the fourth ray

of the latter. Size of specimen about ¾ in. in diameter each way.

Obs. This species in the structure of the body (for, as before stated, there is no differentiation now into cortex and wall, and very little between the excretory canal-system and the cloaca) is very much like *Teichonella prolifera*, from which, however, it not only differs in general form, but in the presence of the large, stout, curved acerates instead of large quadriradiates on the surface as in the latter, and in a slight tendency to a cloacal termination of the excretory systems, wherein the typical form of the cloaca is becoming lost in the enlargement of its holes and their branching off into the canalicular structure of the interior.

40. *Leucaltis floridana*, H., var. *australiensis*.

Specimen massive, without particular form, looking as if it had grown over some marine rubbish, stems and stuff of some kind in a floating or unfixed state; lobed irregularly; lobes, where existing, conical, compressed, with or without a mouth, but with no peristome. Colour dirty yellowish brown. Consistence firm, hard, especially in the dry state. Surface rough and harsh to the feel, from the projecting rays of *large* triradiates plentifully mixed with the smaller ones, or staple size of the body, presenting here and there low gentle elevations in tolerable uniformity, and also here and there a tract of granulated appearance, consisting of small conical or tent-like forms about 1-40th in. in diameter, 1-100th in. high, and 1-40th in. apart. Pores, as usual, in the reticulation of the surface. Vents numerous, large and small, scattered irregularly over the surface, the larger ones only leading into genuine cloacas, the others into simple dilatations of the structure; surface of the cloaca smooth, rendered very uneven by large and small holes, at wide but variable distances apart, deeply sunk into the body-structure through wide infundibular depressions which finally end in openings of the canals of the excretory system, echinated apparently as much by the arms of triradiates as by the fourth arm of quadriradiates. Structure of the body consisting of densely cancellated parenchyma traversed by the branches of the excretory canal-system, supported on a skeletal fabric composed chiefly of small radiates plentifully mixed with very large ones, undefined either by a cortical layer externally or a cloacal one internally. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, very minute, thin, straight, cylindrical, about 100-6000ths in. long by 1-6000th in. in diameter; 2, triradiates, large and small, more or less equiradiate and equiangular, ray of the former averaging 282

by 51-6000ths, and of the latter 36 by 3-6000ths, thus the larger triradiate is eight times as large as the smaller one, which, on the other hand, is the most numerous, or the "staple spicule" of the body; 3, quadriradiates the same as the small triradiates in size, but, of course, provided with the fourth arm, which, as usual, is smaller than the rest. No. 1, the acerates, confined to the surface, where they are arranged tent-like or in a conical form, rising up from a common layer of the same kind on the surface; no. 2, the triradiates, large and small, confined to the body-structure without any evident arrangement; and no. 3, the quadriradiates, mixed with them, of the same size as the staple or small triradiates, but less numerous, also sparsely echinating with their fourth arm the surface of the larger excretory canals, as before stated. Size of the largest specimen, which is dry, rather compressed, oblong, and rounded on the projecting points, apparently produced by attrition while floating about the bottom of the sea, $7\frac{3}{4}$ in. long by $3\frac{3}{4} \times 1\frac{1}{2}$ in. in its other diameters, but very irregular.

Obs. The brown colour of this sponge, both wet and dry, its irregular form, its harsh prickly feel from the arms of the large triradiates projecting beyond the common level of the surface, together with the internal structure, which is a mixture between the cloacal and canalicular excretory systems, and its spiculation, render the species as unmistakable in itself as it is unmistakably like Häckel's *Leucaltis floridana* (Atlas, Taf. xxvi.); as, however, there does not appear to have been any of the *minute* acerate spiculation on the latter, and after much search I have been able to find only one *large* quadriradiate among the *large* triradiates, I have designated it a variety of *Leucaltis floridana*, as the heading will show.

For a calcareous sponge the great size of the largest specimen, viz. $7\frac{3}{4}$ in. long &c., may be considered very unusual. Sometimes the surface presents a reticulation of more or less broken ridges in high relief.

41. *Teichonella prolifera*, Carter.

Teichonella prolifera, Carter, Annals, 1878, vol. ii. p. 35, pl. ii. figs. 1–5.

Finally we come to this species, which simply consists of parenchymatous structure traversed by excretory canal-systems which, beginning by small branches in the interior, terminate respectively by open naked mouths at the surface; supported on a staple mass of small radiates, accompanied more or less plentifully by very large ones, which, from their much greater size, are rendered very conspicuous (see my illustrated

description, *l. c.*). Thus we have no longer any *cortical* differentiation on the surface, nor any *cloacal* cavity interiorly, but a so far simplified structure that it becomes identical with that of the common run of *non*-calcareous sponges.

There are several specimens of this sponge in Mr. Wilson's collection, all more or less like that which I have described (*l. c.*), viz. the largest averaging 3 inches high in their present state, that is after having been broken off from their base of attachment, by 5 × 5 horizontally, formed as usual of an erect, thick, interfolded lamina with round undulating border in which the vents are situated. When fresh these specimens are said to have presented a "greenish-slate and reddish-brown tint below," now whitish yellow throughout.

In the paper on the "Teichonellidæ," to which I have alluded, will be found another species under the name of *T. labyrinthica*, which, through Mr. Wilson's specimens, I have now found to be so nearly allied in structure and general character to *Grantia compressa*, that it has been considered desirable to remove it from the Teichonellidæ to the vicinity of that sponge, where my reasons for so doing have been more particularly stated (*suprà*, p. 38).

Parasitic Cell in Teichonella prolifera.

One of the specimens of *Teichonella prolifera* is remarkable for being densely charged with the minute nucleated cell, like the human blood-globule, which, in my paper on the Parasites of the Spongidæ ('Annals,' 1878, vol. ii. p. 165), I have described under the name of "*Palmella spongiarum.*" Besides being in size and shape like the human blood-globule, it in like manner presents a *pink* tinge, whereby a white sponge, when dry, such as *Halichondria panicea*, Bk., wherein I first found it at this place (Budleigh-Salterton, Devon), becomes coloured by it; and this may account for the "reddish-brown" tint when fresh to which I have alluded. Moreover, this parasite forms half the substance of an incrusting form of an *Aplysina* covering a mussel-shell which is among Mr. Wilson's collections; and the same is the case with a specimen of *Esperia*, from S.W. Australia, which I previously possessed; so that its existence is general.

Summarily it might be stated that Mr. Bracebridge Wilson's collection of S. Australian calcareous sponges has been sufficient to lead us from the simplest structure to one which is identical with that of the ordinary run of non-calcareous sponges, and that therefore, however much it may be desired to make the former a distinct "class," these facts do not justify such a conclusion.

P.S.—Since the above was written, I have found a much larger and more typical specimen of *Lelapia australis*, Gray (to which I have given particular prominence on account of its connexion with fossil species), which by accident had been overlooked in one of Mr. Wilson's later collections from "Port Phillip Heads," and therefore take this opportunity of appending a description of it as follows:—

Lelapia australis, Gray.

Cylindrical, clavate, the largest part upwards, somewhat curved or bent upon itself, rugose longitudinally. Consistence firm. Colour dark grey. Surface even, smooth, interrupted by the projection of crooked ridges extending from the free to the fixed end, subspirally and longitudinally, in broken lengths, sometimes reduced to mere scattered tubercular points, most pronounced on the concave side towards the mouth, least so on the opposite side; largest and most continuous ridge 1-3rd in. long, 1-48th in. broad, and 3-48ths in. high. Pores plentifully scattered over the surface, not remarkably large. Vent single, terminal, represented by a narrow, elliptical opening about 1-3rd in. in its longest diameter, so constricted in the centre as to be closely approximated by an infolding of the lip on each side; provided with a peristome whose spicules here are broken off short; leading into a cloaca corresponding in shape with the specimen, that is wide above, narrowed to a point below (after which the stem becomes solid); in other respects the same as that above described. Structure of the wall, which is about 5-24ths in. thick, together with the spiculation, also much the same as above described; but with these exceptions, viz. that the large acerate spicule of the "body" appears to traverse the wall horizontally as well as longitudinally; while the "ridges" are composed of a mass of acerate spicules of different lengths and thicknesses, averaging 150 by $2\frac{1}{2}$-6000ths in., some of which are simply pointed at each end, others bent and lance-shaped at one end and simply pointed at the other, and a third bent and lance-shaped at each end; all in contact longitudinally with each other, forming a wedge-shaped mass whose narrow end or border, according to the length of the ridge (that is whether linear or reduced to a small tubercular point), is slightly sunk into the wall, and the other, whose spicules, like those of the peristome here, are broken off short, spread out into the ridges of the surface, where the cuticular layer of "mortar-spicules" banks it up on each side. In a dried fragment these masses, in the section especially, present the glistening white aspect of the peristome. Size of specimen

from end to end, across the arc of the curve, $3\frac{1}{4}$ inches; greatest diameter, which is towards the head, 1 inch; least diameter, at the fixed end, which has been broken off from the place of attachment, $\frac{3}{8}$ inch.

Loc. "Port Phillip Heads."

Obs. Besides being far larger than the specimen above described, which I always thought to be more or less deformed, this one probably presents us with the *typical* characters of *Lelapia australis*, and hence my object in appending the above description. It must also, independently of its "typical" value, be considered a large calcareous sponge as the latter generally run. The spiculation may be a trifle larger than as above described, but the ridges are an entirely *new feature*, which in their characters are alone sufficient to distinguish the species; while the large acerate spicules of the body, arranged both transversely and longitudinally in the wall, represent the large sagittal triradiates of the "inarticulate" calcareous sponge-structure; the rest of the spicules here, including that remarkable form, viz. the "fork-like triradiate," to which I have above alluded as being so interesting in connexion with the fossil species *Sestrostomella*, being dwarfed into comparative insignificance.

XVI.—*Descriptions of four new Species of Butterflies from Burmah.* By H. Grose Smith.

Papilio Adamsoni.

Upperside. Anterior wings brown-black, darker towards the base, the nervures and rays between the nervures black. Posterior wings the same colour as the base of the anterior wings, paler towards the anterior margin, crossed beyond the middle by an irregular band of five rosy-white spots, the spot nearest the anterior margin cordate, the next three conical and lunulated externally, the fifth spot at the anal angle nearly obsolete; below the band are three submarginal large spots, lunular, the innermost grey flushed with rosy carmine, the middle spot grey, less rosy, the third the same colour as the band.

Underside. Anterior wings as above, but paler. Posterior wings with the band brighter, larger, more regular and curved, containing six spots, the spot on the anterior margin nearly square, the second the largest and nearly divided by a

black mark, the third, fourth, fifth, and sixth smaller, the spot next the anal angle bright carmine; the three submarginal lunular spots also larger, the two lowest bright carmine, the third brightly tinged with the same colour. Palpi and body carmine, the latter broadly striped with black.

Expanse $4\frac{1}{2}$ inches.

Habitat. Burmah, on the Siamese frontier, near the Salween river. Taken by Capt. Adamson, R.E. Nearest to *P. Aristolochiæ*, but very distinct.

In the collection of Mr. Adamson.

Papilio mehala.

Upperside. Male dark brown, irrorated with ferruginous scales. Anterior wings with a minute white spot at the end of the cell, also on the margin at the ends of the discoidal and median nervules. Posterior wings irrorated in the region of the anal angle; beyond the middle is a band of seven spots, the spot on the costal margin creamy white, nearly square; the second, third, fourth and fifth the same colour, elongated, the third being the longest, the second, third, and fourth lunulated externally, the fifth smaller, and the sixth and seventh still smaller and pale brown; six small submarginal lunular spots and a small spot on the outer margin, the four nearest the anal angle pale brown, the others white, the margin between the nervures white.

Underside. Anterior wings irrorated, as above, towards the apex, paler, the spot at the end of the cell larger, and a double row of minute white spots on the margin. Posterior wings, the spots are whiter, the band smaller, and the submarginal row larger.

This butterfly belongs to the "*Castor*" group.

Expanse 4 inches.

Habitat. Toungoo, Burmah.

In the collection of H. Grose Smith.

Nymphalis Nicholii.

Anterior wings slightly falcate.

Upperside. Blue-black, dark brown towards the base, and nervures also brown, crossed beyond the middle by a double row of white spots, hastate inwardly, the two lowest of each row being confluent and tinged with yellow; below the spots at the inner angle is a yellowish-white longitudinal band extending nearly halfway along the inner margin; white marks on the margin between the veins, hardly visible towards

the apex, and gradually becoming more distinct towards the inner angle. Posterior wings dark brown at the base, covered with long brown hairs, the outer half creamy white tinged with yellow, and deeply dentated by the dark brown colour of the base, which partially follows the veins; the veins at the margins have hastate markings; a submarginal row between the veins of black spots, white in the centre, the second spot nearest the costa being the largest, and geminate spots at the anal angle. The first median nervule slightly projects, forming an indication of a tail.

Underside. Pinkish grey with numerous dark markings, crossed in the middle of both wings by an irregular dark band, and growing paler towards the margins. Thorax and abdomen brown. Antennæ black.

Expanse $3\frac{1}{2}$ inches.

Habitat. Burmah.

A beautiful and distinct species, in shape resembling the *Polyxena* group, but the tail is less pronounced.

In the collection of H. Grose Smith.

Neptis cineracea.

Upperside. Both wings greyish black mottled with brown. Anterior wings crossed beyond the middle by a greyish-white band broken into three spots—the first trifid, the second and third bifid; a narrow white band and conical spot in the cell, and a submarginal row of small white spots curved inwardly towards the anterior margin. Posterior wings with a greyish-white band of spots within the middle, and beyond the middle a row of oval spots, distinct and shaded with grey, and a faint submarginal line of grey.

Underside. As above, the grey shade on the white spots more pronounced, the submarginal row of spots with a greyish-brown interrupted line on each side; the base of the posterior wing broadly white on the interior margin, and the row of spots beyond the middle with an interrupted line of greyish white on each side.

Expanse $2\frac{1}{4}$ inches.

Habitat. Toungoo, Burmah.

Differs from "*Nata*" in the narrower and more acute shape of the wings, the narrow band in the cell, the colouring of the spots, the upper part of the middle bifid spot on the anterior wings not projecting beyond the lower, and the spots of the row beyond the middle of the posterior wings being nearly round instead of oblong, shaded with grey, and distinct.

In the collection of H. Grose Smith.

XVII.—*On* Proteleia* Sollasi, *a new Genus and Species of Monaxonid Sponges allied to* Polymastia.

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[Plate V.]

AMONGST the many new and interesting Monaxonid sponges obtained by the 'Challenger' there is one which, while closely agreeing in most respects with the Suberitid genus *Polymastia*, is distinctly marked off from all species of that genus by the possession of a very remarkable spicule, which, both in form and position, strongly calls to mind the characteristic "grapnel" of the Tetractinellida.

Through the kindness of Mr. Murray, Director of the 'Challenger' Commission, we have been enabled to publish in this place a short account of this interesting sponge, whose well-marked characters entitle it to form the type of a new genus. As the chief points of interest concern its spiculation and its relation to other forms as thereby indicated, we shall not attempt here any histological description of the soft parts, reserving any remarks which may be required on that head for our forthcoming Report on the 'Challenger' Monaxonida.

Although it is always more or less hazardous to base a generic diagnosis on a single species, yet the convenience of such a diagnosis is so great that it is preferable to give one, on the understanding that it may be subject to alteration when more species are discovered.

Genus PROTELEIA.

Sponge sessile, corticate; upper surface covered with mammiform processes; skeleton-spicules spinulate and (or) acuate, and also a spicule with a grapnel-like apex projecting freely beyond the surface of the sponge. No flesh-spicules.

The genus undoubtedly belongs to the family Suberitidæ.

* *προτέλεια*, a beginning; so called because it possesses the rudiment of a grapnel-spicule.

Description of Species.

Proteleia Sollasi.

Sponge sessile, apparently coating (it has been torn off from its attachment), consisting of a flattened cake-like expansion with slightly convex upper surface, from which arise abruptly numerous short, thick, cylindrical, mammiform projections of various sizes. The single specimen in the collection is about $2\frac{1}{2}$ inches long by $1\frac{1}{4}$ broad and not quite half an inch thick; the mammiform processes vary somewhat in size, being when full-grown about $\frac{1}{3}$ inch long by $\frac{1}{6}$ inch in diameter at the base; these processes are almost solid and very stiff and firm, contrasting strongly with those of such forms as *Polymastia robusta* and *P. mamillaris* in this respect; at present they are all closed at the summit, and it is doubtful whether any opening exists in the living sponge, though what appear to be traces of such can be found. Colour in spirit yellowish grey. Texture tough and leathery, internally coarsely fibrous; the cortex is very firmly adherent to the underlying tissues. Surface between and on the mammiform processes even, seen in sections to be minutely hispid; hispidity more strongly marked over the body, where also there is a considerable amount of foreign matter collected, than on the mammiform projections, which are almost glabrous in appearance. Vents (? minute, at summits of papillæ). Pores scattered (? singly) over the surface of the body and of the mammiform projections.

Skeleton: (a) *Of the main Body.*—(1) A thin, very dense, and compact external layer (Pl. V. fig. 1, *b*), about ·15 millim. thick, composed of vertically-placed, tightly-packed, small, straight, and slender spinulate spicules, with their apices directed outwards and projecting for a short distance beyond the surface of the sponge. (2) Immediately below the above and inseparable from it a similar but very much thicker layer of larger, stout, spinulate spicules, arranged as in the first layer, and with their apices imbedded in it (Pl. V. fig. 1, *c*); thickness about ·35 millim. These two layers together may be regarded as the cortex. Besides the spinulate spicules already mentioned there are, in the cortex, spicules of another and very remarkable kind—the grapnel-spicules, to be described later. These have the base and a portion of the shaft imbedded in the cortex, while the remainder of the spicule projects freely for a considerable distance beyond the surface of the sponge, and bears at its extremity the grapnel. Immediately below the cortex, as above defined, comes a layer, about as thick as the second cortical layer, of still larger,

stout, spinulate spicules, not vertically disposed, but for the most part horizontally and irregularly, forming a compact mass. Below this layer comes the general parenchyma of the sponge, enclosing very numerous, scattered, spinulate spicules and very well-defined stout fibres, composed of large acuate or subspinulate spicules longitudinally placed, and with their apices outwardly directed. These primary fibres run vertically towards the surface of the sponge; before arriving there they expand into divergent brushes of large spicules, whose apices penetrate right into, or even through, the cortex. Secondary skeleton-fibres, if present at all, are very ill-defined.

(b) *Of the Mammiform Processes.*—The cortex and the layer immediately below it are arranged very much as in the main body, except with regard to the grapnel-spicules, which seem to be entirely absent; then come very definite, stout, longitudinally-placed bundles of spiculo-fibre (Pl. V. fig. 2, *a*), arranged mainly and fairly regularly in two concentric circles, and with the spaces between them filled with a great number of irregularly but closely-arranged spinulate spicules; in the centre of the inner circle of fibre-bundles is a space almost quite free from spicules and filled with a yellow granular substance. The fibres are like those of the main body.

Skeleton-spicules.—(1) Small, slender, very slightly curved, sharply and gradually pointed spinulate spicules with not very well-developed oval heads (Pl. V. figs. 5, 5 *a*); size about ·157 by ·0045 millim.; these spicules occur in the outermost layer of the cortex. (2) Much larger, very stout, sharply pointed, fusiform spinulates, with roundish heads; size variable, about ·22 by ·019 millim.; in the lower cortical layer, passing gradually by spicules intermediate in form and size into (3) the long acuates of the fibres (Pl. V. fig. 3); these are smooth, straight, fusiform, and sharply and gradually pointed at the apex; size about 1·2 by ·03 millim. (4) The grapnel-spicules (Pl. V. fig. 1, *d*, and figs. 6, 6 *a*, 6 *b*); small, long, very slender, with more or less expanded base, and tapering very gradually to hair-like fineness towards the apex, ending finally in a small knob provided with recurved teeth. The teeth seem to be not quite constant in number; commonly there are three or four, but it is extremely difficult to say which, owing to the minute size of the spicule; sometimes the teeth are absent, leaving only the knob (Pl. V. fig. 6 *a*). Length of spicule about ·52 millim., thickness at thickest part of shaft about ·0063 millim. Often the axial canal of the spicule is much inflated in the terminal knob, and occasionally it presents traces of branches towards the teeth.

There are no flesh-spicules of any kind.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fathoms.

As already stated, the relations of this sponge are undoubtedly with the Suberitidæ, yet it is quite distinct from all previously known species, and we create for it a new genus, which we place near to *Polymastia*. Probably Prof. Sollas's species *Radiella schœnus* (=*Polymastia capitata*, Vosm.), to be mentioned later, comes very close to it.

By far the most interesting feature in this new sponge is the remarkable grapnel-spicule and its bearing upon questions of classification, more especially upon the relations of the Monaxonida to the Tetractinellida. The upshot of this is that the sponge in question adds a new and very important link to the chain of evidence in favour of supposing the Tetractinellida to be derived from the Monaxonida. The present occasion seems to be a favourable opportunity for summarizing the evidence which has now been accumulated in favour of this view. Professor Sollas has very kindly favoured us with his views on the subject, which have been indicated from time to time in his various papers. One of the most important links is to be found in the genus *Tetilla** :—"*Tetilla* is a genuine though somewhat divergent member of the corticate Choristidæ, with close affinities to the Desmacidina; it links together the suborders Tetractinellida and Monaxinellida. The evidence for this statement is found first in its embryological development, next in the characters of the Esperiad *Rhaphidotheca Marshall-Halli*, Kent. In the embryo we find some of its tetractinellid spicules in course of development; they commence with a swelling at the distal end of large uniaxial spicules, from which afterwards teeth are budded off one by one. This is true both for the grapnel- and fork-shaped spicules. Thus the uniaxial clearly precedes the tetractinellid form in development, a fact of signal importance in the discussion as to which originated first, Monaxinellida or Tetractinellida, and in complete correspondence with observations made on the order of development of the spicules in the Calcispongiæ.

"In the next place, in *Rhaphidotheca Marshall-Halli* we find the distal ends of some of the large spicules which project from the skeletal fibres beyond the skin distinctly thickened into globular or oval or cylindrical bulbs, in which the axial thread ends in a slight spherical expansion. . . . . The rounded swelling of the distal ends of projecting spicules is not confined to *Rhaphidotheca*; I have it in a less marked form in a suberite to which I give the name of *Radiella schœnus* (σχοῖνος, a bulrush)."

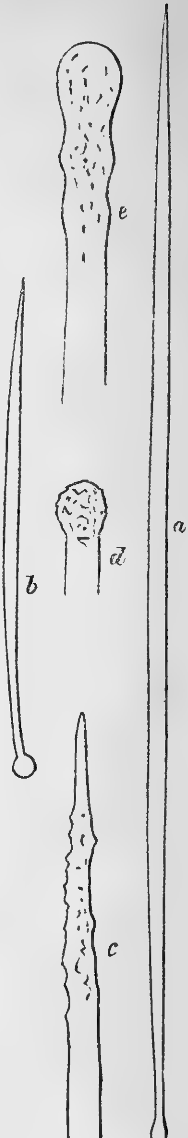
Professor Sollas has kindly sent us preparations and

* *Vide* Sollas, Ann. & Mag. Nat. Hist. March 1882, p. 162.

tracings of the spicule in *Radiella schœnus* (*vide* annexed woodcut). The ends of the chief spicule, which project beyond the surface, are swollen, granulated, and minutely spined. He says (*loc. cit.* p. 163):—"The swollen terminations of the spicules of *R. schœnus* suggest the possibility of a polyphyletic origin for the Tetractinellida."

It is important to notice that, as mentioned by Sollas, it is the projecting ends of the *main* skeleton-spicules, and not of the small cortical spicules, which in *Polymastia* (*Radiella*) *schœnus* become swollen; while in *Proteleia Sollasi* the ends of the small cortical spicule become modified.

Evidence of very much the same kind as to the mode of origin of the tetractinellid spicules is afforded by the Tetractinellid sponge *Thenea Wallichii*, P. Wright*:—"The slender spicules of the anchoring-fibres, over which the ectoderm extends, are mostly rounded at the distal end, like many of the spicules of *R. schœnus*, or the forms which so frequently occur as varieties amongst the pin-shaped acuates. These represent the first stage of the grapnel-spicules, which thus differ from the similar spicules in *Tetilla* by the absence of an initiatory inflation. In the next stage these spicules exhibit near the distal end a number of little tubercular excrescences, similar to those which occur as abnormal thickenings on many of the spicules both of the Monaxonidæ and the Tetractinellidæ. In many cases these tubercles take the form of small teeth, often recurved, and varying in number from one to six. They are seldom situated at the extreme end of the spicule, usually a little distance from it. In the larger specimens we find a considerable advance in growth and development; the spicules show a marked increase in size; and



Radiella schœnus, Sollas: *a*, chief spicule; *b*, spicule of cortex; *c*, *d*, *e*, ends of the chief spicules which project beyond the surface and are swollen, granulated, and minutely spined.

* *Vide* Sollas, Ann. & Mag. Nat. Hist. June 1882, p. 450, pl. xvii. figs. 33–42.

though some of these larger forms still present a merely rounded end, others possess in addition from one to three short conical teeth budded off at some little distance before the end. There is still not the slightest trace of any terminal inflation, such as occurs in *Tetilla*-grapnels. The rays arise merely as spines, precisely similar at this stage to the more numerous spines which cover the distal end of the quadriradiate spicules of *Tricentrium muricatum.* We may indeed, on the basis of these observations, regard the rays of these grapnels as highly developed spines, which, at their inception indefinite in number, become subsequently limited to three."

Leaving now the embryological evidence, which clearly demonstrates that the tetractinellid spicule is derived from the monaxonid form, we must turn to the evidence afforded by several species usually recognized as Monaxonid sponges. First of all it must be observed that the actual number of rays to the spicules in Tetractinellid sponges is by no means constant. Prof. Sollas has very kindly supplied us with information on this point: he tells us, "the variability in number of the teeth is a matter of no moment, so long as they do not frequently *exceed* three. Most *Tetillas* exhibit extreme variability in this respect, the same sponge frequently presenting forks or anchors with one, two, or three teeth."

We have already referred to the evidence afforded by the Suberitid sponge *Polymastia* (*Radiella*) *schœnus.*

Of other Monaxonid sponges with polyaxial skeleton-spicules the genus *Acarnus* forms a very good example. Both the known species of this genus possess grapnel-spicules echinating the skeleton-fibre in tufts. Each spicule has a rounded base attached to the skeleton-fibre, a straight smooth shaft, and a grapnel-like apex; in the one species the number of teeth in the grapnel is four (*A. innominatus*), and in the other three (*A. ternatus*). It is of great importance to notice the position of the grapnel-spicules in this sponge—that they occur within the body and not, as in the Tetractinellida, mainly radiating from the surface; in the one case there is a radiate arrangement, and in the other there is none; hence, though *Acarnus ternatus* possesses grapnel-spicules whose well-developed teeth are almost constantly three in number, yet, having regard to other features, such as the arrangement of the skeleton, it will be seen to come not nearly so close to the Tetractinellida as does *Proteleia.*

In another very interesting monaxonid sponge obtained by the 'Challenger' and to be described fully in our report, under the name *Thrinacophora funiformis,* there is, amongst other

linear skeleton-spicules, one which has a long, smooth, usually crooked shaft, evenly rounded off at the base, and at the apex branching into several short blunt processes, like the fangs of a human tooth; here, it appears, that we have a polyaxial spicule comparable to the forked spicules of the Tetractinellida, derived from the monaxonid type by furcation of the main axis instead of by the outgrowth of spine-like processes. The central canal appears to branch together with the spicule. The systematic position of this sponge is very doubtful; it forms the type of a new genus which, owing to the presence of trichite sheaves, we have included amongst the Desmacidinidæ; but it has very strongly marked axinellid characters and is far removed from the Suberitidæ.

One of the most interesting and important sponges which bears upon this question is the species described by Prof. Sollas in the 'Annals and Magazine of Natural History' for January 1879 (p. 17), under the name *Plectronella papillosa*, a species which subsequently proved to be identical with *Tricentrium muricatum*, Ehlers. This monaxonid sponge, which the author refers to the family Ectyonidæ, possesses an echinating skeleton-spicule which is normally triradiate and occasionally quadriradiate. "These are true quadriradiate spicules, and thus seem to lead on to the tetractinellid type." Carter * also refers this sponge to the family Ectyonidæ; but Vosmaer † considers it a Tetractinellid.

All this evidence seems to lead to the conclusion that the presence of a tetractinellid spicule is in itself not a sufficient guide as to the systematic position of any given sponge, that it may arise independently in different groups of sponges, and that the Tetractinellida are by no means so far removed from the Monaxonida as is generally supposed; indeed, Prof. Sollas tells us that he began to doubt long ago how far the Tetractinellida form a natural group. There seems now to be no doubt that they are derived from monaxonid forms, but whether they have originated polyphyletically or not is another question; so far as spiculation is concerned they may very well have done so; but this is not the place for a discussion of this question. The new sponge which we have here described forms a very important link in the chain of evidence, and as such seemed to be deserving of special notice.

In conclusion we take this opportunity of thanking Prof. Sollas for the invaluable assistance which he has given us in compiling this short account.

* Ann. & Mag. Nat. Hist. ser. 5, vol. iii. p. 293, pl. xxvii. fig. 13.
† Bronn's 'Klass. u. Ordnung. des Thierreichs, *Porifera*,' p. 322.

EXPLANATION OF PLATE V.

Proteleia Sollasi.

Fig. 1. Vertical section through surface. ×44. *a, a,* primary skeleton-fibres; *b,* outer layer of cortex; *c,* inner layer of cortex; *d,* grapnel-spicules; *e,* accumulation of foreign matter on the surface.
Fig. 2. Transverse section of mammiform process. ×12. *a,* sections of skeleton-fibres; *b,* outer layer of cortex; *c,* inner layer of cortex.
Fig. 3. Large acuate skeleton-spicule. ×120.
Fig. 3 *a.* Smaller acuate skeleton-spicule. ×190.
Figs. 4, 4 *a.* Large, stout, spinulate skeleton-spicules. ×190.
Figs. 5, 5 *a.* Small, slender skeleton-spicules. ×190.
Fig. 6. Grapnel-spicule. ×190.
Fig. 6 *a.* Grapnel-spicule, with terminal expansion, but no teeth. ×190.
Fig. 6 *b.* End of one of the grapnel-spicules. ×500.

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Memoirs of the Geological Survey of India. Palæontologia Indica, being Figures and Descriptions of the Organic Remains procured during the Progress of the Geological Survey of India. Published by Order of His Excellency the Governor-General of India in Council. Ser. x. *Indian Tertiary and Post-Tertiary Vertebrata.* Vol. III. Parts 7 and 8. *Siwalik Crocodilia, Lacertilia, and Ophidia; and Tertiary Fishes.* By R. Lydekker, B.A., F.G.S., &c. With 10 plates (xxviii.–xxxvii.) Calcutta: Geological Survey Office. London: Trübner & Co. 1886.

The Crocodilian fauna of the Siwalik rocks is closely allied to the existing Indian types, but is remarkable for the great development of Gharials, two of which were animals of larger size than any living representatives of the group. The descriptions commence with a short account of the characters of fossil allies of living crocodiles, which have been described from Tertiary and Cretaceous strata. Three recent Asiatic species of the genus *Crocodilus* are known and two fossil forms are now described. *C. sivalensis* is well known from crania and other remains, extending from the Punjab through the Siwalik hills to Burma. It is closely allied to *C. palustris,* and differs in the greater width of the interorbital bar, in the more backward position of the anterior nares, the rougher sculpturing of the premaxillary bone, and some other characters; but the author observes that the variety of *C. palustris* from Ceylon approximates nearer in some respects to the fossil than to the other Indian forms, and hence the Siwalik species is regarded as the ancestor of its existing ally. It is not without interest that the *C. Hastingsiæ* of the Headon beds closely resembles the crocodiles of the *C. palustris*

type in the suture between the maxillary and premaxillary bones. *Crocodilus palæindicus* of Falconer is known from the Siwaliks of Perim Island in the Gulf of Cambay. Falconer recognized its affinity to *C. palustris*, and the author points out characters in which it differs from the species already described, especially in the transverse character of the suture between the premaxillary and maxillary bones and in the convexity of the facial profile. It has the ninth tooth large. In the facial sculpture the extremities of the premaxillary bones are almost smooth, as in *C. palustris*; the interorbital bar is narrower than in *C. siamensis*. All living crocodiles present considerable variation, in what might at first sight be supposed to be specific characters, at different stages of growth; and the author would probably admit that many of our fossil species may hereafter be modified as these facts in comparative anatomy become recorded.

Mr. Lydekker suggests that the North-American Cretaceous genus *Holops* should probably be included in the genus *Gharialis* (Geoffroy), and accordingly gives a provisional definition of this well-known existing type, so as to include *Holops*. From the circumstance that the genus occurs in the Upper Cretaceous of France and the Bracklesham beds of this country, the author concludes that it migrated eastward from Europe during the Tertiary period. The *Gharialis gangeticus* is well represented as a fossil in the Siwalik hills, in Burma, the Punjab, and Perim Island. At the present day it is found in Bengal, the North-west Provinces, Akyab, and the Indus basin. The species *G. hysudricus* was larger then *G. gangeticus*, with which it closely agrees in palatal characters; but the width of the bar between the temporal fossæ is much greater than in the existing species, and it has the orbits closer together. The remainder of the species are characterized by having pits in the cranial rostrum for the majority of the teeth in the mandible. *G. curvirostris* has but a slight expansion of the premaxillæ, and has not the eversion of the orbits seen in existing species; it is found in the Lower Siwaliks of Sind.

G. leptodus (Falconer and Cautley) is limited to the Siwalik hills and Eastern Punjab. The fifth species, *Gharialis pachyrhynchus*, is known from the Lower Siwaliks of Sind. It is a very large species, which most resembles the *G. curvirostris*. Its premaxillary teeth are larger than those in the maxillary bone. It is supposed to have measured from 50 to 60 feet in length. A new genus, *Rhamphosuchus*, is formed for some Gharial-like remains in which the premaxillary bones are separated from the nasal bones, and do not form an expanded end to the rostrum, while the splenial bones make a considerable part of the mandibular symphysis. Falconer alluded to this type as forming a passage from the Gharials to the true Crocodiles, and the type species is now described as *R. crassidens*. It is supposed to have been about three times the size of the existing Gangetic Gharial, but with a shorter rostrum. A dorsal scute is upwards of 7 inches long by fully 4 inches wide. The species is characterized by a pit in the cranium, which receives the

fourth mandibular tooth; but the dentition as a whole is suggestive of the alligator type.

The only fossil lizard from the Siwalik hills is the *Varanus sivalensis* of Falconer, and the only serpent *Python molurus* (Linn.), known from vertebræ collected by Mr. Theobald in the Punjab. This part of the work concludes with a list of memoirs relating to the reptile types described.

The eighth part is a description of the Siwalik fishes. A majority of the remains which have been determined belong to the families Ophiocephalidæ and Siluridæ, which at the present day are important elements in the Indian fish-fauna. But some of the fossil Siluroid fishes have marked affinity with African types. The sharks of the Punjab and Pegu are referred to *Carcharias* and *Carcharodon*. The only ray described is the *Myliobatis curvipalatus*, a new species from the Eocene of Katch.

Descriptions follow of *Capitodus indicus*, a species of *Ophiocephalus*, a new species of *Clarias* (*C. Falconeri*), a new species of *Heterobranchus* (*H. palæindicus*), *Chrysichthys Theobaldi*, *Macrones aor*, *Rita grandiscutata*, two species of *Arius*, and *Bagarius Yarrelli*. Another fish is provisionally referred to the Cyprinodontidæ, and *Diodon Folii* is a new species from the Eocene of Ramri Island. The part concludes with a preface to the work, which states that the Siwalik and Narbada Vertebrata are now described. There is a table of contents and index to the volume, and introductory observations in which additional notes are given upon a number of the types described, while a new species, *Mastodon Cautleyi*, is illustrated with several woodcuts. The author may be congratulated on the completion of his labours and on the excellent illustrations which the later work contains. It is a great advantage to all students to be able to consult these figures; and the author's descriptions direct attention to the more striking characters of the fossils. Probably succeeding writers may take different views concerning the nomenclature and even the affinities of some of the fossils, but will acknowledge their obligation to Mr. Lydekker for bringing the Vertebrata of the Siwalik rocks and the problems they suggest once more under the notice of naturalists, in a complete history.

Les Glandes du Pied et les Pores Aquifères chez les Lamellibranches. Par le Dr. Théodore Barrois. 4to. Lille, 1885.

Considering the nature of the byssus of the Mollusca it may perhaps seem rather curious that any doubt should ever have existed as to its origin and significance. It has no doubt been generally regarded as the secretion of peculiar glands, but naturalists of eminence have chosen to give it a very different interpretation, namely that it consists of a bundle of dried or chitinized muscular fibres. This idea seems to have originated with De Blainville in 1825, and was more or less distinctly supported by J. Müller and Wagner, and at a later date by Leydig, who declared, in 1856, that "what is called the byssus consists of chitinized muscular fibres." The last effort in this direction was made by Nathusius Königsborn in 1877, so that the notion has persisted to a tolerably recent date.

Soon after the last-mentioned date MM. Carrière and Théodore Barrois undertook independently elaborate reseaches for the purpose of settling the question, and the description of the investigations of the latter zoologist forms the first part of the volume before us. M. Barrois has examined over sixty species of bivalve Mollusca belonging to the most various groups, and the result of his investigation has been to convince him that the byssus is certainly a secreted organ, and that traces of it are to be found in nearly all the families of the Lamellibranchiata. In its most complete condition it consists of—1, the byssus itself; 2, the groove with its glands; 3, the canal of the byssus; 4, the cavity of the byssus with its glands. Of these the last is apparently the most important part, as it is there that the materials of the byssus are secreted, and in those forms in which the byssus is highly developed this cavity is divided by a multitude of vertical lamellæ into a number of secondary cavities, each of which gives origin to one of the roots of the byssus. The glands which line this cavity are of two kinds, some continuous with the glands of the groove, and the others of much smaller dimensions, which generally occur only in those forms which have the byssus highly developed. The author seems to be inclined to consider the latter only a modification of the glands of the groove, which of themselves seem to suffice for the production of a true byssus.

Upon all these points and many others M. Barrois furnishes us with very full information, and his work ought finally to set at rest the question of the true nature of the byssus.

The second section of his book treats of a subject, the importance of which was forced upon him during his investigation of the glands of the foot in the bivalve Mollusca, namely, "the introduction of water into the circulatory system of the Lamellibranchiata through the so-called *pori aquiferi.*" This is a subject upon which a greater variety of opinion has prevailed than even with regard to the origin and nature of the byssus, and the analysis of the literature relating to it given here by M. Barrois shows to how great an extent it has attracted the attention of naturalists. The author agrees with those who maintain that there is no intermixture of water with the blood of the Mollusca; he denies the existence of the intercellular passages destined to facilitate this intermixture, described by several writers, and declares the supposed *pori aquiferi* of other naturalists to be the apertures of the byssogenous apparatus, having no communication with the lacunar system of the foot. The organ of Bojanus he considers to be already put out of court by the researches of many naturalists, and hence he concludes that there is no direct communication between the exterior and the circulatory system, and that the blood is never mixed with water. The turgescence of the foot. which was supposed to be due to the influx of water into the circulatory lacunæ, he regards, with Fleischmann and Ray Lankester, as caused by the sudden transfer of blood from the great reservoirs of the mantle to the spongy tissue of the foot.

We have given here only a very imperfect notion of the contents of this volume, which gives the detailed results of some admirable work upon two matters of considerable importance in the natural

history of the Mollusca. The book is well and fully illustrated with two plates containing numerous figures, mostly showing the appearances seen in thin sections of the parts under consideration.

Annual Report and Proceedings of the Belfast Naturalists' Field-Club, 1884–85. Series ii. vol. ii. part v. 8vo. Belfast: 1885.

The Annual Report of the Society's affairs is followed by a pleasing *résumé* of the summer and autumn excursions and of winter indoor meetings. Besides the Address, by Mr. W. H. Patterson, on the ancient literature and history of Ireland, there are notes and papers:—On the Mosses of Mourne Mountains, on the Gilled Fungi of North Ireland, and on a quantity of Deer's Horns found near Maralin, by the Rev. H. W. Lett; on the Lignites and Silicified Wood of Lough Neagh, by Mr. W. Swanston, F.G.S.; on an ancient Helmet of Iron and Bronze from one of the Crannoges of Antrim (?); and on the Scale Mosses and Liverworts of Co. Down, by the Rev. C. H. Waddell. The meteorological summary for 1885 and list of members &c. complete this part of the 'Proceedings.' Appendix ix. follows, containing:—

1. "The Recent Ostracoda of Belfast Lough," by Dr. S. M. Malcolmson. Besides notes on specimens and species, we have here two elaborate tables, showing the distribution of Ostracoda in the Irish Channel and Belfast Lough, with positions, depths, and bottoms of the dredgings, and references to the descriptions and figures of the many known species met with. Six forms new to Britain are recorded; three of these are new species and are duly described and figured, namely *Loxoconcha cuneiformis*, *Paradoxostoma truncatum*, and *Bythocythere pavo*; and one new to Britain is also figured, *Cytherideis foveolata* (pl. xxvi.). Dr. G. S. Brady, having aided the author in his researches, is duly acknowledged.

2. "The Fungi of the North of Ireland, Part I.," by H. W. Lett, M.A. (Trin. Coll. Dubl.), after an appropriate introduction enumerates 581 species, with their localities and references.

3. "Foraminifera of the Belfast Naturalists' Field Club Cruise off Belfast Lough, in the Steam-tug 'Protector,' June 1885; also Foraminifera found by Dr. Malcolmson at Rockport, Belfast Lough," by Joseph Wright, F.G.S. In this memoir the author, including, with corrected nomenclature, the Foraminifera recorded in his former paper (Proc. Belfast Nat. Field Club, Appendix, 1876–77), enumerates all the species now known on the north-east part of the Irish coast. Besides notes on some of the species he gives a long table showing distribution and relative abundance, and supplies a plate of twelve of the most interesting species (pl. xxvi.). The help given by Mr. H. B. Brady, F.R.S., in this work, and by Dr. Malcolmson in the illustrations, is acknowledged.

4. "A List of the Cretaceous Foraminifera of Keady Hill, County Derry," by Joseph Wright, F.G.S., is an important addition to the author's researches upon the Microzoa of the Irish Chalk, &c. (Proc. Belfast Nat. Field Club, 1874, Appendix, p. 73). Twenty-five species new to the Cretaceous fauna of Ireland are indicated among the many here enumerated; and five new forms are illustrated, with ten

others, in pl. xxvii., drawn by Dr. Malcolmson. Prof. T. Rupert Jones also is thanked for help given.

5. "A List of Irish Coleoptera collected mainly by the late Robert Patterson, Esq., F.R.S., in the year 1829." This useful contribution to the series of local lists in Natural History, besides its intrinsic value, shows "how much could be accomplished in a year by one quite young and fully occupied in business matters. This, too, at a time when books of reference were much less accessible than at present."

MISCELLANEOUS.

On the Significance of Conjugation in the Infusoria. By Dr. A. Gruber.

In what follows I will briefly communicate an observation which seems suited to throw some light upon the still obscure nature of the conjugation of the Infusoria. My investigations relate to *Paramæcium aurelia*, of which Infusorian I have been able to employ a very considerable number of conjugated individuals for preparations. It is well known that Ickeli * has lately stated that from his preparations he has been able to conclude that there is a migration of the nucleoli from one individual to the other, a process which Bütschli † had previously supposed to take place in the same Infusorian. The main point of the whole process has, however, escaped both these naturalists, whose publications I shall refer to in more detail elsewhere. This consists in the fact *that the nucleoli of the two individuals come into intimate contact with each other, copulate with each other.*

The two conjugated individuals of *Paramæcium* are closely united together, besides their anterior parts, at a point in the hinder third of the body. To this point, which is indicated by a sort of annular swelling, there moves from the left and right a nucleolus converted into a striated spindle (Bütschli's "Nucleoluskapsel"); the two bodies touch one another exactly in the bridge of communication, at first only by their apices and then gradually more intimately, so that they appear mutually flattened, and finally two bodies originate from them which meet together by their broader ends, and exactly fill up the above-mentioned bridge of communication.

Without going into minute details and into the further course of the process I will content myself with having established the fact that in *Paramæcium aurelia* the conjugation brings about an intermixture of nuclear substance from both sides; and this seems to me to explain much or most of what was enigmatical to us in the phenomena of conjugation, and to furnish us with a firm support for the view which brings the conjugation of the Infusoria into direct agreement with the sexual reproduction of the Metazoa. As in the

* "Ueber die Kernverhältnisse der Infusorien," Zool. Anzeiger, Jahrg. vii. 1884, p. 491.

† "Studien über die ersten Entwicklungsvorgänge &c.," Abh. Senck. naturf. Gesellsch. Bd. x. 1876.

Metazoon the nuclei of the germ-cells, so here the so-called nucleoli come into intimate contact, and the result here as there is an intermixture of different germ-plasmas. With Weismann, I am convinced that this result is the purpose of both sexual fecundation and conjugation, and the condition of the variability of the individuals, without which species-production would be impossible.

With the certainty that in the phenomena of conjugation the essential thing is the exchange of nuclear substance in the two conjugated individuals, we stand on much more solid ground for the explanation of these processes, and may for the future drop all more indefinite notions. Among these we have as the chief the most generally entertained opinion, which indeed is apparently supported by facts, that the purpose of conjugation is the rejuvenescence of Infusoria exhausted by continual division *.—*Berichten der naturf. Gesellschaft zu Freiburg I. B.* Band ii. (1886) Heft 1.

On the Influence of certain Rhizocephalous Parasites upon the External Sexual Characters of their Host. By M. A. Giard.

Most of the Rhizocephala parasitic upon the Decapod Crustacea occasion the atrophy of the genital glands of their host without the external sexual characters of the latter undergoing the least modification. Thus *Sacculina triangularis*, Anderson, which occurs pretty frequently at the Poulignan, and more rarely at Concarneau, upon *Platycarcinus pagurus*, affects both males and females, widely projecting on each side of the narrow tail of the former, while it is entirely protected by the broader appendage of the other sex.

But this is not always the case, and in some instances the parasite by its presence causes modifications so extensive that the infested males become like the females in types in which sexual dimorphism is most strongly marked. A very distinct example of this is furnished by *Sacculina Fraissei*, sp. nov., a parasite of *Stenorhynchus phalangium*, Penn. This *Sacculina*, indicated but not described by Fraisse in the Bay of Naples, occurs commonly at Concarneau, in the Baie de la Forest. We may estimate at one in fifty the number of *Stenorhynchi* infested by this Rhizocephalan. As in the case of the *Sacculina* of *Carcinus mœnas*, the parasite arrives at its complete formation during the period of reproduction of the crab, that is to say, in the present case, during the months of June and July.

Sacculina Fraissei is easily distinguished from other species of the same genus by its external form and its organization. It is entirely concealed in the kind of box formed by the tail of the crab and the sternal plastron. Its outline is heart-shaped. The cloacal aperture is nearly sessile, irregularly triangular in the young. The chitinous ring which surrounds the peduncle is very simple and not strongly marked. The peduncle is short; the roots are thicker and more irregularly ramified than those of *S. Carcini*; the collateric glands are well developed and situated upon the sides and towards the upper third of the height. The orientation is the same as that of *Sacculina carcini*. The nearly spherical testes are situated at the

* The author promises a more detailed paper with figures.

median part of the posterior half of the ovaries nearly at the centre of figure of the parasite; they give origin each to a long deferent duct, which reaches the posterior margin and turns round it to open in the supra-peduncular region. *Sacculina Fraissei* therefore belongs to the group of *mesorchideous Sacculinæ*, the type of which is *Sacculina corculum*, Kossm., parasitic upon *Atergatis floridus*.

At first it appeared to me that only the females of *Stenorhynchus* were infested by the parasite, which appeared the more surprising because in *Stenorhynchus phalangium* the number of males is much greater than that of the females. A more careful examination showed me that the male sex has no indemnity, although it seems to be less frequently attacked (about one in six).

In the females the influence of the parasite makes itself felt externally by a profound modification of the four pairs of ovigerous feet. These appendages are much reduced, although we cannot attribute their atrophy to wearing caused by the friction of the *Sacculina*. I have indeed ascertained that in adult females in which the recently evaginated *Sacculina* was still small, the ovigerous feet already presented the poor appearance of aborted organs.

I soon observed infested *Stenorhynchi*, apparently quite similar to the preceding, in which these feet did not exist at all, but in which I easily found copulatory styles, greatly reduced it is true, and a different position of the genital aperture. These individuals were males, the tail of which, however, had all the external characters of the female appendage, and seemed arranged so as to shelter the parasite as perfectly as it shelters the ova in the other sex.

Moreover, the secondary sexual characters of these infested males were also modified in the same direction as the primary characters. The chelæ, instead of being strongly developed, were reduced, and did not much exceed the head as in the normal males; in one word they presented the same arrangement as in the females. All these peculiarities are the more striking because in the normal condition *Stenorhynchus* is one of the Brachyurous Decapods in which sexual dimorphism is best shown.

To find facts comparable with those just set forth we have to invoke the effects produced by castration in the higher Vertebrata, and the appearance in eunuchs of certain secondary sexual characters usually belonging to the female sex.

From another point of view, the false finality, unfavourable to the crab, which causes the appearance in one sex of a character of the other sex with the apparent object of protecting a parasite, is not the only example presented to us by nature of this sort of struggle between natural selection and sexual selection. Do not we see the stamens of *Melandryum dioicum*, normally aborted in the female sex, become developed nevertheless when the plant is infested by *Ustilago antherarum*, so that the plant becomes, *apparently*, hermaphrodite in order to allow of the fructification of the parasite?

It is probable that the observations which I have made upon the *Sacculina* of *Stenorhynchus* may be extended to other species, and especially to the *Sacculina neglecta* of *Inachus scorpio*, which, according to Fraisse, only infests the females. Therefore I make a point of declaring that I abandon the argument which I had drawn from

this against the theory of the migration of the embryo of the Rhizocephala. I also add that all the facts contained in this note are perfectly well explained under the hypothesis of direct fixation which still appears to me much the most probable.—*Comptes Rendus*, July 5, 1886, p. 84.

The Bed-Bug and its Odoriferous Apparatus.
By M. J. KÜNCKEL.

I have ascertained that the young *Cimices*, on issuing from the egg, bear three odorific glands, situated in the dorsal region of the abdomen. These glands occupy the median portion of the first three segments; all three, of the same dimensions, when seen under the microscope affect the form of a more or less inflated satchel; their outline exactly reproduces the contour of a melon-glass, with the bottom turned towards the head. Each gland opens externally by two orifices, placed on either side of the median line, and arranged transversely at the margin of the first, second, and third tergites, just over the line of separation of the segments; they have the aspect of open button-holes.

If we examine the young bugs when their digestive tube is gorged with blood, it is impossible, on account of their opacity, to perceive the odoriferous glands; to study these we must render the insects transparent by means of special artifices. We shall not at present describe their histological structure, but merely remark that they are cutaneous glands formed by a fold of the skin; moreover, after treatment with caustic potash we can ascertain that the cuticle of the integument is continuous with the invaginated cuticle which lines the interior of the gland.

These three *abdominal and dorsal* glands persist until the last change of skin; they then become atrophied and are replaced by a *thoracic and sternal* glandular apparatus. The Cimicides, which drink blood, like the Scutellerides, Pentatomides, Coreides, Lygæides, &c., which suck sap, are therefore provided with two systems of organs of secretion, situated in two opposite regions of the body, according as they are in the state of larva or pupa, or in the adult state.

The presence at different ages in the same insect of glands having different anatomical relations, but possessing the same physiological attributes, is a fact which leads us to interesting deductions. In fact when I first indicated it, in 1866 *, I endeavoured to explain it, and I said that the glands of the pupæ became atrophied, because in the Pentatomides and others the scutellum, elytra, and wings coming to cover the superior arches of the abdomen, would place an obstacle in the way of the performance of their physiological function; but the bed-bug having only a short scutellum, small elytra, and no wings, the tergites of the abdomen are never covered, and it would seem that my explanation was defective: it will suffice for me to remark that this Hemipteron is an aberrant type, transformed by adaptation, that is to say, having lost its aerial locomotor organs to conform to a sedentary existence subordinated to the biological conditions imposed by its cohabitation with man; on the other hand,

* 'Comptes Rendus,' 2e semestre, 1866, p. 483.

the presence of the two glandular systems, as in the Hemiptera furnished with organs of flight, demonstrates that originally the *Cimices* possessed normally-constituted elytra and wings.

Some naturalists, indeed, have thought that these creatures, when adult, represented the pupa-state of other Hemiptera, and that the number of moults justified their opinion. Now the disappearance of the larval and pupal odoriferous glands coincides with the appearance of new odoriferous glands, the exclusive appanage of the adult Hemiptera: then the *Cimices* capable of reproduction and regarded as pupæ are not able after another moult to acquire wings; they are creatures which have attained the last term of their development. If, like *Pyrrhocoris apterus* * of the family Lygæides, they are capable of becoming winged, this would be at the time of the last moult, and the appearance of the elytra and wings of normal constitution would coincide with the disappearance of the abdominal glands and the appearance of the metathoracic glandular apparatus.

If the discovery of the odorific glands of the larvæ and pupæ belongs to me (1866), the discovery of the odoriferous gland in these adult Hemiptera was made by Léon Dufour (1833); but it was Leonhard Landois who ascertained the presence of the glandular apparatus in the bed-bug (1868) †. According to him this apparatus consists of two long bursæ, accumulating the secretion of a single median gland and gradually uniting in an excretory duct situated in the mesothorax and opening between the posterior legs by a single orifice! This is all wrong. It consists in reality of a pair of elongated appendiculate bursæ, of equal length, arranged symmetrically on the two sides of the median line, between the cavities of insertion of the posterior legs; each of these bursæ opens by a distinct orifice into a trapezoidal sac which occupies the whole metathoracic sternal region included between the line of separation of the mesosternum and metasternum and the insertions of the third pair of legs; the base of this sac is bilobed, and presents behind, on either side of the median line, two groups of minute glandular cæca. This sac opens externally by a pair of orifices placed in a depression on the sides of the metasternum at the level of the insertion of the third pair of legs; these orifices are placed on either side of a prolongation of the mesosternum which extends between the legs.

To sum up: the bed-bug, from the time of its hatching, in the state of larva and pupa, possesses three dorsal, abdominal, odoriferous glands, which disappear at the last moult, and are replaced in the adult state by a metathoracic sternal glandular apparatus. The presence of this apparatus is a criterion which enables us to prove that the *Cimex* has completed its evolution.—*Comptes Rendus*, July 5, 1886, p. 81.

* This Hemipteron, as was seen by Paul Meyer (1873) and as I have verified, in the larval and pupal states possesses three abdominal glands which disappear at the last moult when the metathoracic sternal gland is formed; during very warm and dry summers I have several times observed in individuals collected in the Botanical School of the Museum the simultaneous production of well-formed wings and of the metathoracic sternal gland.

† Zeitschr. f. wiss. Zool. Bd. xviii. p. 218, pl. xii. fig. 14.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 105. SEPTEMBER 1886.

XVIII.—*On the Genus* Hindia, *Dunc.* By Dr. H. Rauff *.

The genus *Hindia* was established by Duncan in an excellent memoir †, for some very insignificant-looking, more or less perfectly globular bodies from the Lower Helderberg group of New Brunswick, which he named *Hindia sphæroidalis*. He had received the fossils from Hinde, who had previously ‡ described them briefly as a Tabulate Coral under the name of *Sphærolites Nicholsoni*. Duncan recognized the sponge-nature of the bodies and the tetracladine character of the sponge-skeleton ; but the circumstance that in the specimens before him the latter were calcified, and the presence in them of a vegetable parasite (?), *Palæachlya penetrans*, Dunc., prevented his actually referring the sponge to the Tetracladina, and rather led him to the notion (which I believe to be erroneous, and to which I shall recur hereafter) that we have here an Upper Silurian, and therefore the earliest known, Calcisponge, the skeletal elements of which are constructed upon the type of the Tetracladina.

* Translated by W. S. Dallas, F.L.S., from a separate impression, communicated by the Author, of his memoir in the 'Sitzungsberichte der Niederrheinischen Gesellschaft zu Bonn,' 10th May, 1886.

† Ann. & Mag. Nat. Hist. ser. 5, vol. iv. (1879), p. 84, pl. ix.

‡ Abstracts of Proc. Geol. Soc. no. 305 (1875).

Hinde himself has since * designated the bodies as *Hindia fibrosa*, F. Römer, sp., after recognizing that they were identical with certain specimens determined by Römer as *Calamopora fibrosa*, F. Römer (non Goldfuss), from Tennessee †. Hinde, in his 'Catalogue,' referred the species to the Anomocladina, while Zittel ‡ was inclined to regard the skeleton as Megamorine. While both these naturalists thus recognized and confirmed the sponge-nature of the bodies, Steinmann § has recently declared with great confidence that they, or at least the fossils occurring in the North-German diluvium, and referred to *Hindia fibrosa* ||, are not sponges at all, but a species of *Favosites*, and that consequently there seems to be no reason for designating the fossil known from Tennessee and from the North-German diluvium by any other name than the original one of F. Römer, *Calamopora* = *Favosites*, for *Hindia* possesses not a single one of the peculiarities characteristic of the Siliceous Sponges—no stomachal cavity, no canal-system such as we are acquainted with in Sponges, and no spicular structure!

By the gratifying suggestion of Prof. von Zittel that I should prepare in association with him a complete monograph of the fossil Sponges occurring in Germany (a work which was commenced some months ago for the Palæozoic species), I was enabled also to study the question here referred to upon excellent materials from Tennessee and New Brunswick in the Museum at Munich, probably including a specimen made use of by Duncan in his investigations, with some preparations belonging to it ¶. At the same time, by the kindness of the owner, Privatdocent Dr. Haas of Kiel, I was able also to submit to examination the specimens from the island of Sylt investigated by Steinmann; and a specimen from the St. Petersburg Silurian **, designated as *Chætetes petropolitanus*, which I obtained from Krantz, of this place (Bonn), contributed not a little to add to the certainty of my observations and to demonstrate the identity of the American and German specimens.

* Hinde, 'Catalogue of Fossil Sponges in the British Museum' (1883), p. 57, pl. xiii. fig. 1.

† F. Römer, 'Silurfauna westl. Tennessee' (Breslau, 1860), p. 20, pl. ii. fig. 2.

‡ Neues Jahrb. f. Min. 1884, ii. p. 79.

§ *Ibid.* 1886, i. p. 91 (Briefl. Mitth.).

|| On the occurrence in North Germany, see also F. Römer, 'Lethæa erratica' (1885), p. 63 (310), pl. iv. (xxvii.), fig. 17, in Dames & Keyser's 'Paläontologische Abhandlungen.'

¶ Presented by Hinde to the Munich Museum.

** See F. Römer, 'Silur-Geschiebe von Sadewitz,' Breslau, 1861; what is said of *Monticulipora petropolitana*, p. 26.

In what follows I shall not give the details and the full account of all my observations, which would be impracticable without figures from the microscopic objects, and must remain over for a larger memoir; with regard to the form, the texture of the surface, the structure of the fractured surfaces with their radial streaks, and many details of the microscopic appearances we can refer to Duncan's excellent description. The additions and corrections, chiefly relating to Duncan's microscopic observations, which I have now been enabled to make by the more abundant material at my disposal will appear of themselves upon a comparison of what follows with Duncan's memoir; I would here only communicate the essentially new results relating to the wonderful, perhaps unprecedentedly regular and elegant construction of the sponge-skeleton from the individual elements as it appears to me from the microscopic preparations, and which perhaps may serve to give these bodies, so insignificant in external appearance, quite a peculiar interest.

From the central point of the spheres *—it must remain a question whether around this there was a small cavity or a foreign body (Hinde), or whether the tissue originally possessed a somewhat different and looser structure (Duncan)—there radiate in all directions thin, perfectly straight canals, which differ somewhat from each other in diameter, are slightly widened externally, and are increased in number towards the surface by the interpolation of new ones; these present a more or less regular transverse section, and their perforated walls are formed by quadriradiate, tetracladine skeletal elements.

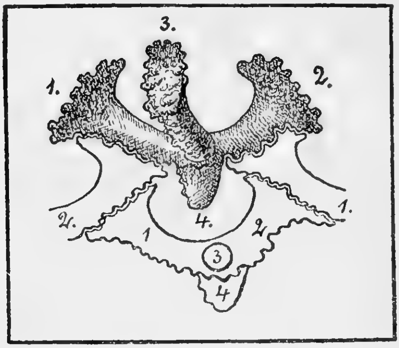
The typical tetracladine element consists of four arms radiating from a point, and arranged in space in the same way as the lines running from the centre of gravity of a tetrahedron to its four angles, or, which of course is the same thing, the perpendiculars from this centre of gravity to the surfaces of the tetrahedron. The four arms are therefore equally distributed in space, and meet each other at an angle of $109° 28'$; but the projections of each three rays in a plane of projection perpendicular to the fourth (that is to say, therefore, the projections of three rays upon the surface of the tetrahedron defined by the apices of these rays) enclose $120°$ between each two rays.

The elements of *Hindia* appear to be all very similar. In radial sections the microscope usually enables us to recognize only two arms distinctly, as the elements are rather large, and the thin sections, to furnish distinct images, must be kept very thin in proportion to this size; of the third arm only the broken

* I have them before me of 10–45 millim. in diameter.

or amputated cylindrical stump is then recognizable, while the fourth is very seldom observed, and, in fact, appears generally

Fig. 1.



to be rudimentary or entirely deficient. It may be remarked, however, that it has several times been recognized with certainty.

The two distinct rays present a very characteristic form; they are curved in the same direction, the concave margin always appears smooth, the convex one always toothed, and each of the extremities of the arms (heads), which are widened in a direction about perpendicular to the arm, and lie in the same surface of the canal-wall with the arm, are also toothed on the outer margin. As all the radial sections appear to be equivalent, *i. e.* furnish the same images, we are justified in assuming that the third arm also has the same structure as the two just mentioned, and that the diagrammatic representation in fig. 1 (the shaded part) may represent the *Hindia* element *.

These individual elements are united to one another in a remarkable manner. When the connexion of the skeleton is preserved in the preparation, we see, as in the diagram fig. 2 (p. 174), radially directed rows of meshes, of which we can usually determine two or three neighbouring ones as belonging

* Tangential sections, indeed, show three arms distinctly, but, for reasons which will appear hereafter, these do not allow the specific peculiarities of the *Hindia*-element to stand out clearly; as we examine them from above they appear straight, not curved, and without allowing the dilatations of the heads, the denticulation of the convex sides of the arms, and the peculiar mode of connexion of the latter to be recognized clearly and as the rule.

to the same canal; the meshes in every two laterally contiguous rows always stand alternately, by which a very elegant image is produced. In certain good parts of the preparation it is clear that the nodes (central points) of the laterally contiguous elements are also placed alternately, and that the union is effected in this way: the widened and denticulated head of one arm meets the convex and likewise denticulated main portion of the arm, lying in the same face of the canal, of that laterally contiguous element whose nodal point does not lie in the same transverse section with the first one, but about half a nodal distance (half the height of a mesh) above or below it. Thus the arms 1 and 2 of one element (fig. 1 and tube I. in fig. 2) always unite respectively with 2 and 1 of the neighbouring elements on each side. At the same time the arms of all the elements lying on the same radius are parallel in direction, so that two arms, 1 and 2, not belonging to the same element but to laterally neighbouring ones, always come to lie in the same face of the canal-wall. Moreover, all the convex sides of the arms are always turned in the same direction, namely outwards towards the surface, and all the concave ones towards the central point. For the canals represented in fig. 2, therefore, the central point of the sponge is to be sought in their prolongation upwards.

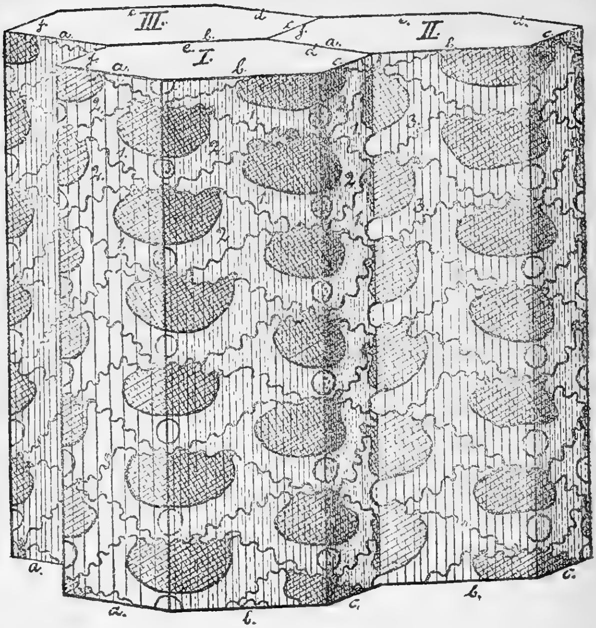
As the heads do not meet, but always the head of one arm with the main portion of another, the trabeculæ of the skeleton (measured sideways between the meshes) when the sutures do not show distinctly or are obliterated, or under only a low power, appear much thicker than they are in reality, in fact often about twice as strong.

If we now suppose that, as everything seems to show, the third arm is equivalent to the first two in position, in structure, and generally in its relations within its own element and to the neighbouring ones, and that the fourth arm is rudimentary or deficient (its development, however, would by no means alter the principle of structure here put forward, the assumption of such a development being only unobserved, whilst in point of fact, as indicated in fig. 1, the presence of a free unattached stump (4) projecting into the mesh from the nodal point could frequently be recognized),—if we make this supposition with regard to the third arm, the skeleton, by the constant uniformity of the mode of union of all its members, will naturally form itself into nothing but six-sided radial tubes, each contiguous pair of which will always have a common wall.

In fig. 2 the three diagrammatically represented hexagonal

canals are indicated as I., II., and III., and their similarly

Fig. 2.



placed surfaces as *a*, *b*, *c*, *d*, *e*, *f*; so that II. *a* coincides with I. *d*, III. *b* with I. *e*, II. *f* with III. *c*, and so on.

The central points of the spicules are then situated in the angles of the six-sided columns, those of the neighbouring radial series alternating as already stated, the rays 1, 2, 3 in the three surfaces meeting in one angle respectively; for example, I. *c*—I. *d*(=II. *a*)—II. *b* (ray 2 not visible, because it is situated in the surface I. *d*, which is turned away from the observer), or I. *a*—I. *b*—IV. *f* (IV. indicating another canal united to I. in the surface I. *b*), or I. *b*—I. *c*—IV. *d*, and so on, the longitudinal direction of the fourth aborted arm (omitted throughout in fig. 2) always coinciding with the angle of the prism. The arms no. 4 of all the spicules placed upon the same angle would therefore, if they were developed, unite the central points of the spicules, as it were materializing the angle and further dividing the mesh-spaces in a radial direction. I have indeed sometimes thought that I observed

such a union of the central points in a radial direction; but it was always doubtful whether the union was not simulated by a trabecula lying above or below: the clearest and most connected images very seldom showed the beam 4 at all, and then quite short and disunited; the casts also indicate undivided mesh-spaces. The abortion of the fourth trabecula also appears quite natural if we consider that the heads of the arms are often so much dilated laterally that they reach to the central point of the spicules with which they are united, and this great lateral growth must in course of time suppress the fourth arm; in connexion with this we have also the circumstance that the concave surface of the arms is smooth, as their denticulation would be superfluous.

This conception of the skeletal structure of the *Hindia*-body seems to me to agree with all the observations, coinciding with them and explaining them.

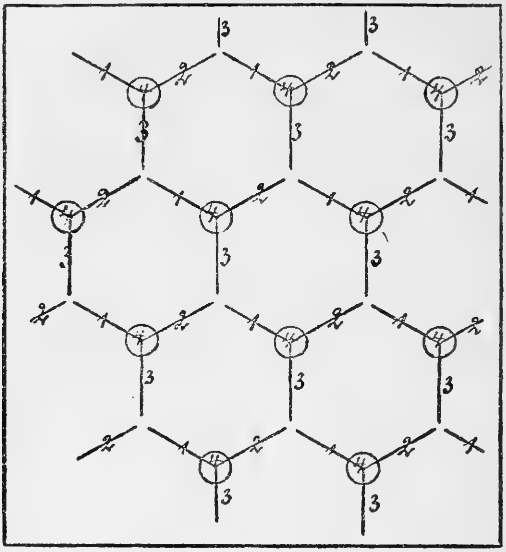
As each individual part shows itself to be tetracladine, so also the whole connexion; the articulation is determined by a law in conformity with this tetracladine character. Each spicule has its four arms uniformly distributed in space (one of them aborted); each pair of arms therefore (theoretically) encloses an angle of $109\frac{1}{2}°$; but several such spicules, when situated upon radial axes (each set of three arms running parallel, while the longitudinal direction of the fourth indicates the radial axis itself), constitute together by these three arms three surfaces cutting each other at angles of 120°, canal-walls. (Projections of these sets of three arms in a surface perpendicular to the fourth arm = transverse sections of the hexagonal column.)

Thus the construction of the whole skeletal body appears to be in the most perfect harmony with the nature of the individual elements, and most perfectly adapted to their character.

Duncan states that the arms usually unite by their "frilled" heads. This statement appeared to me to be confirmed here and there in a radial section, a preparation which Duncan also probably had. But as the specimen from which the preparation was taken is distorted, and as it seems probable, from a concentric fracture in the interior, that a more external part of the sponge has been forcibly pushed inwards, these portions, in which the arms appear to be united in an abnormal fashion and which no longer show the radial streaks, but present a hexagonal form of mesh, may really belong not to radial but to tangential transverse sections. In these transverse sections, however, the peculiar mode of union of the spicules would of course no longer appear distinctly, for we

look only upon the concave parts of the arms, while the convex surfaces, and consequently the points of union, are turned away from the observer; we see in the transverse section the

Fig. 3.

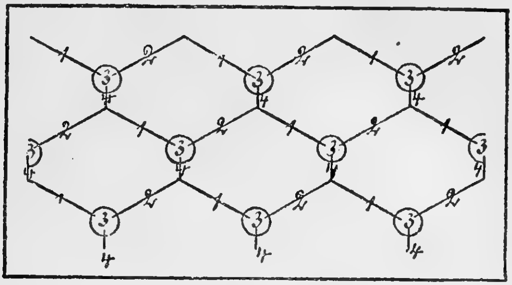


projection of the arms bounding the hexagonal meshes (columns). Where the preparation is not quite clear it then usually becomes impossible to determine whether the three arms meeting to form a triangle belong to the same spicule or to three different ones (see diagram, fig. 3), and thus it often seems as if one head met the other, although this usually is not the case; for where the image is clearer, and especially where at the same time the transverse section bends a little towards the eye, the mode of union above described appears again more or less distinctly, and it is at least by far the predominant one. From this also we learn why the trabeculæ generally appear thinner in the transverse than in the radial section. It is still possible that both modes of union may coexist; the diagram of the latter (in which, however, for unity of construction the fourth ray must necessarily be more or less developed) is shown in fig. 4 for the longitudinal section.

Without going further here into the question of the presence of one or more stomachal cavities, and consequently as to the morphological individuality of the animal, it may be mentioned

that even in certain perfectly globular Astylospongidæ, likewise destitute of a stomachal cavity, the canal-system is of pre-

Fig. 4.



cisely similar nature, consisting merely of radial tubes; the system in *Hindia* therefore is not quite so isolated as Prof. Steinmann states.

In the Astylospongidæ also the individual element and the tectonics of the skeleton seem to be in an analogous way governed by a centripetal mathematical law.

As regards the mode of fossilization and preservation of the *Hindiæ*, the specimens now before me from Tennessee, St. Petersburg, and the island of Sylt are completely silicified, but the skeleton in all is quite hollowed out; but while in the first-named the outermost layer of the trabeculæ is preserved as a thin siliceous husk (at any rate a thin layer sufficient for the preservation of the form), and the original outlines and forms of the skeleton thus still appear in all their distinctness, this husk is deficient almost without exception in those from Sylt, which therefore are true matrices, and the spaces originally occupied by the skeleton are more or less enlarged and eroded. Nevertheless there can be no doubt that the Sylt fossil is identical with those from America and Russia: leaving out of consideration the skeletal husks all the appearances and conditions are the same; in both radial fractured surfaces show the same radial six-sided rods, which are the infillings of the tubes, and on the angles of these the same alternately-placed little tubercles, and the cross bars uniting the rods, which are due to the infilling of the mesh-spaces *. The interstices between these granules and cross bands, as well as the narrow cavities bounding the infillings of the radial tubes in tangential sections, exactly agree in the course, form, and size of the nodal distances with the skeletal

* See F. Römer, 'Tennessee,' pl. ii. fig. 2 *b*, and Hinde, 'Catalogue,' pl. xiii. fig. 1 *a*.

elements described. Even under the lens we also see on radial fractures that these interstices everywhere form the triangle corresponding to the tetracladine spicules; but here and there the thin sections also show the scanty rudiments of the above-mentioned siliceous husks.

In the examples from New Brunswick, on the other hand, the skeleton itself is completely calcified, while the infilling of the mesh-spaces is siliceous. At the first glance it may perhaps appear most natural to deduce from this that the skeleton was originally calcareous; more careful consideration, however, and a whole series of phenomena which occur in these as in other silicified sponges prove that this lime is of secondary nature, a secondary infilling-mass of the originally siliceous trabeculæ which have been excavated during fossilization. Almost all the completely silicified sponges which have hitherto been investigated (Astylospongidæ, *Aulocopia*, &c.) show a completely excavated skeleton, sometimes filled up here and there, or with the inner walls of the skeleton lined with a little calc-spar or brown spar; nevertheless the originally siliceous nature of the skeleton must be maintained, because silicification and excavation of the trabeculæ seem to stand in definite relation and reciprocal action to one another.

As regards the *Hindiæ* especially, it appears very improbable that groups so widely separated genetically as the Calcispongiæ and Silicispongiæ should so perfectly imitate one another in their skeletal parts as would be the case with the *Hindiæ* as supposed Calcisponges and the true siliceous Tetracladinæ. However the secretion of the spicules from the syncytium may take place, the skeleton-secreting structures are comparable to organs; and it does not appear admissible without further evidence that these quasi-organs, which have to perform such a different work in siliceous and calcareous sponges, should bring forth products so surprisingly similar, not only individually but also in their mode of union, as would be the case here. In the Calcisponges there never occurs such an intimate contact and such a mode of union of the spicules as is produced in *Hindia* and the Tetracladina by the dilated extremities of the arms, furnished as they are with granules, nodules, teeth, and pads.

The supposition of the originally siliceous nature of all these skeletons also finds important support in the circumstance that in quite indubitable siliceous sponges, namely the Hexactinellidæ from the Pliocene of Bologna, the skeleton, as Manzoni has proved *, is excavated in a precisely similar

* Manzoni, 'La struttura microscopica delle spugne silicee del miocene medio della provincia di Bologna e di Modena:' Bologna, 1882.

manner; and not only this, but, what is very remarkable, the axial canals are at the same time preserved. Manzoni believed that these axial canals, appearing isolatedly in thin sections without the trabeculæ belonging to them, originally existed in flattened dilatations, which were produced by closure of the mesh-spaces, and consequent coalescence of the skeletal trains lying in the same plane, such as occur especially in the dermal layers in the Hexactinellidæ. I cannot adopt this notion; but after examination of such sponges from Bologna I rather believe that I can prove that the trabecula belonging to each of these axial canals originally existed distinctly, and not amalgamated with the laterally contiguous ones, but separated in the regular way from the latter by the meshes, and that the remarkable phenomenon now presented to us is merely a consequence of the process of fossilization.

The absolute proof of this, as indeed of the originally siliceous composition of the hollow skeleton in *Astylospongia*, *Aulocopium*, *Hindia*, &c., requires the coherent exposition of a whole series of observations, with the considerations arising from them, and would go beyond the purpose and limits of these communications; I may therefore be excused for touching upon this point quite lightly in this place.

As a result, we are justified in concluding from the preceding statements that *Hindia fibrosa* is no doubtful form, not belonging at all to the sponges, as Prof. Steinmann thought he was obliged to assume, but a well-characterized, true tetracladine siliceous sponge.

XIX.—*Professor Claus: a Rejoinder.*

By Prof. E. Ray Lankester, M.A., LL.D., F.R.S.

It is necessary that I should say a few words in criticism of Prof. Claus's attempt in this Magazine (July 1886, p. 55) to justify the statements previously made by him and objected to by me. Professor Claus has chosen to call the charges made against him by me "frivolous." Were I to indulge in the use of descriptive adjectives I should feel obliged to use a somewhat stronger one in reference to his defence of his proceedings. I will, however, merely say that it has not surprised me, and that no one who is acquainted with the history of certain discussions between Prof. Claus and Prof. Weissmann, or again of a similar discussion between Prof. Claus

and Prof. Edouard Van Beneden, can be surprised either at Professor Claus's objectionable article on the classification of the Arthropoda or at his attempt to justify it.

1. Professor Claus now tells us (Ann. & Mag. Nat. Hist. July 1886, p. 56) that he did recognize the relationship of *Limulus* to the Arachnida in his handbook of 1880, and quotes a passage to prove this. The passage merely proves that Claus was not ignorant of the general views of Huxley, Dohrn, and Ed. Van Beneden. The fact remains that he classified the Gigantostraca under the Crustacea, and in his description of that group said nothing of their affinities with the Arachnida.

2. Professor Claus endeavours to saddle me with an opinion as to the existence of twelve segments in the abdominal carapace of *Limulus* which I have never expressed, and quotes with approval (p. 57) some remarks made by Packard on this subject, which do not require refutation, but obviously are due to misconception.

It is important to note that Prof. Claus even now regards the attempt to refer the lung-sacs of the Scorpion to the introverted branchial lamellæ of Limuloid ancestors as "mere trifling." He also endorses Packard's objections to my interpretation of the relationship of the brain and of the simple and compound eyes in *Limulus* and *Scorpio*. Time will show whether the views now rejected by Claus are correct or not. I much prefer to find him expressing a divergence between his views and my own to having to look on whilst he puts forward as new, without any acknowledgment or reference, views which have been previously made the subject of special treatises by his contemporaries.

3. Professor Claus has no reply to the statement made by me that he has, in his paper in the 'Anzeiger' of the Vienna Academy, announced the view that the Acarina are degenerate Arachnida as a new conclusion of his own, whereas I had previously formulated this conclusion—and that, too, as one result of a general consideration of the genetic relationships of the Arthropoda, which is in all essential features the same as that which he has recently put forward as a new thing of his own.

4. The phrase on p. 59, "and the same thing was previously said in the 'Grundzüge,'" appears to me to be entirely inconsistent with fact.

5. The attempt is made by Claus on p. 61 to show that the genealogical tree of the Arthropoda described by him is after all different from that constructed by me. No one who considers the matter attentively will be deceived by the different

appearance which he gives to the two trees. If we leave the word "Insecta" without a query on the left-hand branch of my tree and strike the word out from the other branches of the tree, and if we make the two main stems of the tree drawn by Claus converge to their common base (as they must do and are arbitrarily made not to do by Claus, thus producing an illusory appearance of dissimilarity), the identity of Claus's tree with that previously published by me is clear enough.

6. Prof. Claus erroneously states (p. 62) that I have supposed a new mouth to have formed in the Arthropoda as compared with the Chætopoda. I have made no such assumption. The "adaptational shifting of the oral aperture" in relation to the anterior appendages is, it would scarcely seem necessary to point out, precisely the same thing as the "secondary shifting" of the anterior appendages in relation to the mouth. Yet it is with such a quibble as the assertion that these two phrases describe different processes that Prof. Claus is anxious to defend himself from the charge I have made against him of a want of fairness in the treatment of his predecessors' views as to the homologies and classification of the Arthropoda!

Prof. Claus further has given expression to the remarkable conception that he is justified in ignoring the work of other zoologists, and treating their results as his own, provided that he does so not more than three years after they have published those results. He quotes (p. 63) his work on the Daphnidæ of 1876, as containing the doctrine of an upward movement of the postoral appendages which was, he admits, published by me in 1873; and he wishes the reader to regard this as a justification for his completely abstaining from referring to my publication either in 1876 or in any of his subsequent writings.

Is it possible to believe that Claus really considers that the fact that he published a certain view in 1876 justifies him in abstaining from all reference to an author who published three years previously the same view?

I am of opinion that it was necessary (however unpleasant) to point out emphatically the unfair treatment to which my writings in reference to the Arthropoda have been subjected by Prof. Claus. I felt the more impelled to undertake this unpleasant duty because it is within the knowledge of those who have studied *Seison*, the parasitic Isopoda, and the Daphnidæ, that Prof. Claus is accustomed to escape with insufficient criticism from the results of his peculiar forgetfulness.

I by no means hold that a copious and original observer like Prof. Claus is bound to discuss or to give references to

every isolated observation made by every naturalist who has preceded him in a particular field of work; but I do hold that the deliberate abstention on the part of one occupying a leading position among zoologists from giving any recognition whatever to the writings of a predecessor who has anticipated him (1) in the formulation of such views as those advocated by me and subsequently by Claus as to the classification of Arthropoda, and (2) in the publication of a variety of facts and hypotheses which lead up to this prominent result, is greatly to be deplored—and not only to be deplored, but to be exposed and condemned.

XX.—*On a Collection of Lepidoptera made by Commander Alfred Carpenter, R.N., in Upper Burma, in the Winter of* 1885–86. By Arthur G. Butler, F.L.S., F.Z.S., &c.

The collection of which this is an account consists of 128 specimens, some of them indeed (especially Nymphalidæ) in poor condition, owing to the length of time they had been on the wing when caught, but many of them in a good state of preservation. The number of species obtained was sixty-five, five of which I have been obliged to describe as new; several other possibly new species are not in sufficiently good condition to be fit for description.

Nymphalidæ.

1. *Tirumala leopardus*, Butler.

The typical form was obtained on the 10th January on the Irrawaddy river, opposite Mandalay, and a female of a form approaching *T. conjuncta* at Kabwett (lat. 22° 44′ N.) on the 5th of the same month.

2. *Limnas chrysippus*, Linn.

The female was obtained on the Irrawaddy, thirty miles above Mandalay (lat. 22° 27′ N.), on the 14th December, and two males on the 10th January following.

3. *Salatura genutia*, Cramer.

Both sexes at Myadoung, on the Irrawaddy (lat. 23° 43′ N.), on the 4th January.

4. *Calysisme tabitha*, Fabr.

One male taken at Sheemagar (lat. 22° 19′ N.) on the 12th December; one female without special locality.

5. *Calysisme ostrea*, Westw.

A single small male, without special locality.

6. *Calysisme perseus*, Fabr.

A female obtained on the Irrawaddy, thirty miles above Mandalay (lat. 22° 27′ N.), on the 14th December, 1885.

7. *Calysisme Carpenteri*, sp. n.

Nearest to *C. visala*, but formed like *C. perseus*, pattern and coloration of the upper surface as in the former; under surface more nearly as in the latter, but redder, and crossed by two well-defined black lines, the outer one much less straight than the outer edge of the central belt of *C. perseus* and *C. visala*; the primaries also with an abbreviated dusky line near the base; ocelli, excepting the fifth on the secondaries (which is black), reduced to white points; veins blackish. Expanse of wings 61 millim.

A female taken at Kabwett, on the Irrawaddy (lat. 22° 44′ N.), 5th January, 1886.

The black lines across the wings and the blackish veins on the under surface readily distinguish this species from all the allied forms.

8. *Orsotriœna runeka*, Moore.

A male specimen was obtained in December on the Irrawaddy, thirty miles above Mandalay (lat. 22° 27′ N.).

9. *Ypthima*, sp. n.

One broken male, somewhat rubbed and without exact locality. It appears to come nearest to *Y. ordinata*, but the anal angle of the secondaries is broken away on both sides.

10. *Ypthima Marshallii*, Butler.

Two specimens obtained thirty miles above Mandalay (lat. 22° 27′ N.), on the 14th December.

11. *Ypthima catharina*, sp. n.

Nearly allied to *Y. mahratta* (of which I have twelve specimens before me), but differing in the greyer, less rufous tint of the upper surface, and in the distinctly yellowish

instead of greyish-white ground-colour of the under surface, upon which also are traces of one or two additional ocelli; the form of the indistinct stripe across the secondaries agrees with that of *Y. alemola.* Expanse of wings 28–35 millim.

Katha, Irrawaddy (lat. 24° 9′ N., long. 96° 17′ E.), 3rd January; Myadoung (lat. 23° 43′ N.), 4th January.

12. *Neptis mamaja*, Butler.

Two shattered specimens obtained at Katha and Myadoung on the Irrawaddy, 3rd and 4th January.

13. *Hypolimnas avia*, Fabr.

A rather damaged female at the entrance to the second defile above Shoay Koojee, on the Irrawaddy (lat. 24° 16′ N.), 28th December, 1885.

14. *Junonia lemonias*, Linn.

Six examples, mostly more or less injured, were collected at Sheemagar (lat. 22° 19′ N.) in December, and one male at Katha on the 3rd January.

15. *Junonia laomedia*, Linn.

A female taken at Kabwett, on the 5th January.

16. *Junonia almana*, Linn.

A male obtained thirty miles above Mandalay, on the 14th December.

17. *Junonia œnone*, Linn. (var. *Hierta*?).

One female at Myadoung, on the Irrawaddy (lat. 23° 43′ N.), on the 4th January, and one opposite Mandalay on the 10th of the same month.

18. *Ergolis ariadne*, Linn.

A shattered male was captured at Myadoung.

19. *Atella phalantha*, Drury.

Two much-worn females: one taken at Modah (lat. 24° 18′ N., long. 96° 26′ E.) on the 3rd January, and the other at Myadoung on the 4th.

Erycinidæ.

20. *Zemeros flegyas*, Cramer.

A much-worn male at Katha, on the 3rd January.

Lycænidæ.

21. *Catochrysops cnejus*, Fabr.

A female at Myadoung, on the 4th January.

22. *Catochrysops strabo*, Fabr.

Two males at Sheemagar (lat. 22° 19′ N.), on the 12th December.

23. *Tarucus plinius*, Fabr.

A much broken male was obtained at Kyouk Myoung (lat. 22° 34′ N.), on the Irrawaddy, 21st December.

24. *Tarucus callinara*, sp. n.

Near to *T. nara*, with which both sexes agree on the upper surface; on the under surface, however, they agree with *T. venosus*, the black markings being all much enlarged; the submarginal lunules separate, instead of in a continuous dentate-sinuate line; the series of spots beyond the cell of secondaries quite distinctly arranged, commencing with three spots in a regular oblique series, the third of these forming the first of three spots arranged in a triangle, and beyond these two spots placed angle to angle, the lower one contiguous with the subbasal series. Expanse of wings 24 millim.

Five specimens, of both sexes, taken at Sheemagar in December.

The preceding appears to be a widely distributed species, occurring in various parts of India and flying in May, July, August, September, and December. We have received it in all Col. Swinhoe's collections under the name of *T. theophrastus*, an African species differing considerably from it in the arrangement of the markings on the under surface of the secondaries.

25. *Lampides conferenda*, sp. n.

Hitherto confounded with *L. alexis*, but readily to be distinguished from the fact that it is of a sandy instead of greyish-brown colour on the under surface, and that the whole of the bands are shifted backwards towards the base, leaving a wide pale band between the discal bands and the external border; the submarginal series of spots ill defined; none of the markings distinctly white-edged, and the subanal ocellus of secondaries very small. Expanse of wings 31 millim.

A pair obtained at Sheemagar on the 12th December, and a male thirty miles above Mandalay on the 14th.

This is the commonest form of the *L. alexis* group, and we have specimens from Assam, Silhet, Deyra Doon, Poona, and Calcutta. Though hitherto regarded as a variety of *L. alexis*, it has as much claim to specific rank as any of the species of the *L. elpis* group, the differences being precisely of the same character as in the variously named forms of that group.

26. *Castalius rosimon*, Fabr.

Five examples (of both sexes) were obtained on the 12th, 14th, and 21st December at Sheemagar, thirty miles above Mandalay, and at Kyouk Myoung (lat. 22° 34′ N.).

27. *Castalius approximatus*, sp. n.

Nearest to *C. chota*, but running larger; it differs chiefly from *C. rosimon* in the narrower borders to the wings and in the absence of the last of the discal black spots towards external angle of primaries, the other five spots being well separated; also in the absence of the black spot close to the border of the secondaries towards apex, and in the indistinct and minute character of the marginal spots on the under surface. Expanse of wings 31–32 millim.

A pair taken at Katha, on the Irrawaddy (lat. 24° 9′ N., long. 96° 17′ E.), January 3, 1886.

We have a pair of this form taken in Bombay by Colonel Swinhoe. Whether it is a species or only a well-marked variety nobody can definitely decide without breeding it; at any rate it is as distinct as the other named forms of the group.

28. *Cyaniris*, sp.

A single worn male of a species near to *C. puspa* (and which I have been unable to identify) was taken on the 3rd January at Modah, on the Irrawaddy (lat. 24° 18′ N., long. 96° 26′ E.). We have a second poor specimen of the male from Silhet, and what I suppose to be the female from Darjiling; but none of our specimens are sufficiently good to describe.

29. *Zizera otis*, Fabr.

A male taken at Sheemagar on the 12th December and a female at Modah on the 2nd January.

Z. lysizone of Snellen is identical with this species.

30. *Plebeius putli*, Kollar.

Two examples, at Sheemagar in December.

Papilionidæ.

31. *Delias indica*, Wallace.

The female was taken at Modah (lat. 24° 18′ N., long. 96° 26′ E.) on the 3rd January, and the male at Kabwett (lat. 22° 44′ N.) on the 5th of the same month.

32. *Delias pasithoë*, Linn.

The female was obtained at Mandalay on the 9th January and the male opposite Mandalay on the following day.

33. *Terias santana*, Felder.

A well-marked female at Sheemagar on the 12th December, 1885.

34. *Terias Swinhoei*, Butler.

A male at Sheemagar on the 12th December; it is a little larger and more strongly marked than the majority of the Bombay and Poona specimens, but the differences in other respects are so slight that I do not see how it is to be separated from the present species.

35. *Terias silhetana*, Wallace.

A specimen at Kyouk Myoung on the 21st December and a fragment at Modah on the 3rd January.

36. *Terias purreea*, Moore.

♀. Kyouk Myoung, on the 21st December, 1885, Modah, 3rd January, 1886; ♂. Myadoung, on the 4th of the same month.

37. *Terias excavata*, Moore.

♀. Sheemagar, on the 12th December; and ♂, 30 miles above Mandalay, on the 14th of the same month.

38. *Terias Jægeri*, Ménétr.

Three males were taken at Sheemagar on the 12th December.

39. *Ixias moulmeinensis*, Moore.

♂ ♀. Sheemagar, on the 12th December; ♂. Katha, 3rd January; ♀. Myadoung, 4th January; ♂ ♀. On the river-bank opposite Mandalay, 10th January.

Either this species is slightly variable or it exhibits slight local modifications, such as might eventually become permanent, even if they have not already done so, and thus tend to bridge over the already very slight gaps which separate the species (local forms) constituting the genus.

40. *Catopsilia gnoma*, Fabr.

♀. Irrawaddy river, opposite bank to Mandalay, 10th January.

A small and peculiarly marked specimen, which, however, I can associate with no other named form; if constant in its characters it might be separated as a distinct species.

41. *Catopsilia nephte*, Fabr.

♂. Myadoung (lat. 23° 43′ N.) on the 4th January.

42. *Catopsilia ilea*, Fabr.

♂. Myadoung, 4th January.

43. *Nychitona xiphia*, Fabr.

Three specimens caught at Kyouk Myoung (lat. 22° 34′ N.) on the 21st December.

44. *Appias vacans*, Butler.

A pair (both dwarfed) at Modah, on the Irrawaddy (lat. 24° 18′ N., long. 96° 26′ E.), on the 3rd January, 1886.

The Ceylonese species identified as *A. vacans* in Mr. Moore's work on the Lepidoptera of Ceylon is distinct, the much greater width and dentate character of the border on the under surface of the secondaries being alone sufficient to distinguish it; I therefore propose that it be called *A. aperta*. The pair now received differ from my figure of the type chiefly in size, and must I think be typical; unfortunately we do not possess Darjiling examples.

45. *Ganoris gliciria*, Cramer.

♂. Modah, 3rd January.

The specimen belongs to a somewhat rare sport, in which the black spot of primaries is represented only by a few black scales.

46. *Huphina hira*, Moore.

A single male at Sheemagar, 12th December, 1885. It differs slightly from Mr. Moore's figure, the black spot on the second median interspace of primaries being smaller and less distinctly confluent with the external borders; the under surface of this sex is not described, but in the specimen before me it most nearly resembles that of *H. pallida*, Swinhoe.

47. *Nepheronia gœa*, Felder.

♂ ♀. Modah, 3rd January; Kabwett (pair *in copulâ*), 5th January; on river bank opposite Mandalay, 10th January; ♂. Katha, 3rd of the same month.

48. *Papilio aristolochiœ*, Fabr.

♂ ♀. Sheemagar, 12th December; ♀. Kyouk Myoung, 21st.

The females are mere fragments, both broken and rubbed.

49. *Papilio pammon*, Linn.

One broken female was obtained at Kabwett on the 5th January.

50. *Papilio erithonius*, Cramer.

At Myadoung on the 4th January and opposite Mandalay on the 10th.

Hesperiidæ.

51. *Astictopterus subfasciatus*, Moore.

Two worn specimens at Modah on the 3rd January.

52. *Chapra mathias*, Fabr.

Two males at Myadoung on the 4th January.
" Quick short flight."—*A. C.*

53. *Pamphila augias*, Linn.

One male at Myadoung on the 4th January.

Leucaniidæ.

54. *Leucania collecta*, Walker.

One much-worn male, 30 miles above Mandalay, on the 14th December.

55. *Leucania proscripta*, Walker.

♀. Sheemagar, 12th December, 1885.

Ophiusidæ.

56. *Achæa fasciculipes*, Walker.

♀. Sheemagar, 12th December, 1885.

A worn specimen. Our examples are from the Celebes and Vaté, but there appears to be nothing but size and slightly deeper colouring to distinguish this form from *A. mercatoria*, of which I believe it to be a variety.

Hypenidæ.

57. *Dichromia orosia*, Cramer.

Kyouk Myoung (lat. 22° 34′ N.), 21st December, 1885.

Margarodidæ.

58. *Maruca aquatilis*, Boisd.

One specimen flew on board, Pagan, Irrawaddy river (lat. 21° 12′ N.), 13th January, 1886.

Arctiidæ.

59. *Creatonotus interruptus*, Linn.

♀. Irrawaddy, 30 miles above Mandalay, 14th December.

Lithosiidæ.

60. *Deiopeia pulchella*, Linn.

Sheemagar, 12th December, 1885.

Nyctemeridæ.

61. *Nyctemera lacticinia*, Cramer.

♀. Kabwett, 5th January.

Liparidæ.

62. *Artaxa digramma*, Boisd.

♀. Flew on board (7 P.M.) on the Irrawaddy, 30 miles above Mandalay, 14th December.

Idæidæ.

63. *Hyria grataria*, Walker.

♂. Flew on board, Pagan, Irrawaddy river (lat. 21° 12′ N.), on the 13th January at 9 P.M.

64. *Idæa*, sp.?

Sheemagar (lat. 22° 19′ N.), December 1885.

A worn specimen of a species which I have been unable to identify.

Microniidæ.

65. *Micronia aculeata*, Guén.

♀. Flew on board, Sheemagar, above Mandalay (lat. 22° 19′ N.), on the 12th December at 8 P.M.

XXI.—*Note on* Orbitolites italica, Costa, sp. (*Orbitolites tenuissima*, Carpenter). By Henry B. Brady, F.R.S.

In the paragraphs relating to the distribution of *Orbitolites tenuissima*, in the "Report on the Foraminifera of the Challenger Expedition" (p. 214), attention is directed to certain figures in Costa's "Paleontologia del Regno di Napoli" ('Atti dell' Accademia Pontaniana,' 1856, vol. vii. pl. xvi. figs. 26–28), as follows:—

"*Orbitolites tenuissima* has not hitherto been recognized as a fossil species; nevertheless Costa has figured two specimens which seem to place beyond question its existence in the later Tertiaries of Southern Italy. The drawings referred to are named *Pavonina italica*, and it is impossible to compare them with those in pl. xv. of the present Report, especially with fig. 7, or with the central portion of one of the figures given by Dr. Carpenter ("Report on Orbitolites," pl. i. fig. 1), without the conviction that they are taken from specimens with almost precisely identical characters, although the former, like many of Costa's illustrations, are somewhat lacking in detail. The fossil shells are obviously only fragments, a circumstance sufficiently accounted for by the extreme tenuity of the test." To which is appended the following footnote:—"The author states that specimens are not uncommon in the Tertiary marls of Reggio; it is therefore pro-

bable that the species will be found again in the same or similar deposits. Should the view which I have taken prove correct, the specific name '*italica*' will of course take precedence of '*tenuissima.*' Costa himself appears to have been in great doubt about the Foraminiferal nature of the organism, and suggests that it may even belong to the vegetable kingdom."

Before the publication of the Challenger Report I had been in correspondence with my friend Prof. Seguenza, of Messina, the recognized authority on all matters connected with the palæontology of Southern Italy and Sicily, not less on Microzoa than on the larger fossils, but he was unable at the time to furnish any information on the subject of Costa's figures. Early in the present year, however, I chanced to be myself at Messina, when I again brought the question under his notice; and subsequently, on looking over a collection of Tertiary rock-specimens, he discovered on the fractured surface of one a discoidal fossil bearing a strong resemblance to the drawings referred to. He was kind enough to give me the specimen, and its examination since my return leaves no kind of doubt that it belongs to the species described in the 'Paleontologia,' and, further, that it is identical with the *Orbitolites tenuissima* of Carpenter. The rock is a friable limestone largely composed of Microzoa, and by splitting it carefully fragments of two or three other examples of the same form have been obtained. The fact that the species has not been observed more frequently in Tertiary deposits is no doubt due to the extreme fragility of the shell, and to the process of disintegration, by washing and otherwise, to which fossil material is generally subjected as a preliminary to microscopical examination.

We have now two localities for *Orbitolites italica* as a fossil:—Seguenza's specimens are from the Upper Miocene of Castanea, near Messina; Costa's were from the Tertiary marls of the mainland opposite, namely Reggio, in Calabria. It is interesting to note that the species is still living at many points in the Mediterranean, and that it has been dredged in comparatively shallow water, 100 to 200 fathoms, near the coast of Sicily.

I may add that I have placed the specimens given to me by Professor Seguenza with the collection of Foraminifera exhibited in the Natural History Museum, South Kensington.

Savile Club, Piccadilly,
Aug. 1886.

XXII.—*Larval Theory of the Origin of Tissue.* By A. Hyatt *.

I have endeavoured, in the essay of which this is an abstract, to demonstrate a phyletic connexion between Protozoa and Metazoa, and also to show that the tissue-cells of the latter are similar to asexual larvæ and are related by their modes of development to the Protozoa, just as larval forms among the Metazoa themselves are related to the ancestral adults of the different groups to which they belong. This is indicated by the fact that the tissue-cells exhibit highly concentrated or accelerated modes of development according to a universal law of biogenesis, which has now been found in almost all groups of animals. Thus in forms which stand at the extreme limits of groups in point of specialization of structure, or have unusually protected young, or pathological forms with stimulated development—in fact any forms in which stimulative causes have acted upon the young, so as to bring about an earlier development at the expense of the normal rate of growth—there may be observed an abbreviation of the usual series of structural characters, which appear in the young of normal forms of the same group. The observations of many authors, notably Cope, Häckel, Balfour, Weissmann, Packard, and Wurtemburger, have conclusively proved that examples of abbreviated or concentrated development are the results of a constant tendency in all organisms to acquire characters in adults or later stages of larvæ, and then to inherit these at earlier and earlier stages in successive descendants; thus finally crowding the younger stages until some ancient characters are skipped, sometimes leaving no record of the derivation of the organism, and at others only a highly abbreviated record in the earlier stages.

No bushy colonies of zoöns or cells are built up in the Metazoa, representing the incompletely divided colonies of the adults of Protozoa, except in cases of incomplete segmentation of the ovum. These forms are skipped, and the complex colonies, which arise by fission, consist of zoöns divided by distinct walls. The cycle of transformations is not only shortened by this omission, but the origin of the reproductive bodies is carried back into the earlier stages in many forms,

* From the 'American Journal of Science' for May 1886, pp. 332–347. This article is an abstract of a paper with the same title published in Proc. Bost. Soc. Nat. Hist. vol. xxiii. 1884, pp. 45–163, but has in addition the suggestion that *Volvox* and *Eudorina* are true intermediate forms entitled to be called Mesozoa or Blastrea.

and the rapidity of the processes of complete fission, due to concentration, produces masses of tissue and membranes in place of loosely connected colonies, as among Protozoa *.

The many disconnected wandering cells, with their independent organization and functions, favour this conclusion, and the sight of these and of ova in the mesenchyme of sponges, and the evidence of their functions here and elsewhere in the animal kingdom, is sufficient to bring a candid mind to open confession of the existence of exact parallelism between them and the single individualized Amœba.

These and other morphological facts have led, so far as we know, only to comparisons between the ordinary tissue-cells and the adults of the Amœbæ, and it has been assumed that these cells are the equivalents of the adult Amœbæ.

Morphologically this seems to be true; but it does not account for the physiological differences between the Protozoon and the cell. The ontology of the cell, its production of tissue, and the reduction of the cycle of transformations cannot be explained unless we attribute to it a concentrated energy in reproduction and a tendency to form closely united and complex associations much greater than that of the Protozoon.

Thus a single Metazoon is a colony of infinite complexity in which the two primitive colonies, ectoderm and endoderm, have produced by growth and agamic fission all the anatomical systems and their various organs and smaller parts.

Studies of reproduction show that the succession of events among Protozoa was first growth, then fission, then the union or concrescence of divided zoöns and an exchange of their complementary parts; evidently all of these influences bear upon the tissue-cell and influence its reproduction. Nevertheless two cells do not combine previous to reproduction by fission, and whatever the effect of the original impregnation may be, we are obliged therefore to regard a young cell as a modified agamic larva-like form or zoön when compared with the full-grown Amœba. If descent from Amœbæ through Flagellata and Ciliata is assumed, then the task of proving young cells to be immature forms becomes easier. In this case they are obviously forms which, like the ova of many Metazoa, have retained their ancient amœboidal characteristics, while losing their later-acquired flagellate and ciliate similarities.

We cannot use the words embryo and larva, which belong

* The network of protoplasm connecting tissue-cells is disregarded in order to show the massive nature of tissues and at the same time state their characteristic cellular composition.

to the ovum after impregnation, and we therefore propose to designate the cell an autotemnon *, in contrast with the embryo, which is more specialized. The least specialized tissue-cells of the mesenchyme differ less from the individualized agamic zoöns of the Protozoa, while the spermatocysts, as more highly specialized encysted male zoöns, retain the cycle of agamic transformations derived from their male Protozoonal prototypes, and are intermediate to the encysted female zoön or ovum.

The spermatocyst, in other words, is not dependent upon impregnation for its development, and has necessarily retained more of the characteristic successive transformations of the primitive agamic forms than the ovum. This last has become dependent upon impregnation. The tendency to earlier and earlier impregnation in successive generations, and the correlative concentration of autotemnic stages, as shown by the fission of the nucleus and exclusion of the polar globules, has finally established the ovum as a more highly specialized form of cell.

The conditions of fission in the cyst of a Protozoon and in the ovum and spermatocyst are similar as long as the zoöns or cells are all similarly confined; but when they burst the envelope and become free the surrounding conditions differ, and they correspondingly diverge.

The early encystment of the ovum, the non-production of the colonial form by incomplete fission, the dependence of the feminonucleus upon impregnation, and the great rapidity and extensive character of the changes by which the diploblastic parenchymula and triploblastic gastrula are built up, all show the excessive concentration of development which has taken place, when any blastula is compared with the corresponding forms among the Volvocinæ. There is also a distinction between the mode of development of the Volvocinæ and the lower Protozoa, which has, we think, great significance. They have prolonged gestation, and this can be compared with the similar prolongation of the corresponding period in the early inception of the ovum in the Metazoa.

They are, however, necessarily only single cells. The whole process of segmentation occurs under conditions which effectually protect the earlier stages in the higher Protozoa and in all the Metazoa; but, as might have been anticipated, the more specialized Metazoon elaborates at once and within limits of this early egg stage a fully-formed colony, the blastula, whereas the highest and most specialized of Protozoa

* From αὐτὸς, self, and τέμνω, to divide.

get no further than the production of single ova and spermatocysts *, or the earliest stages of segmentation, during the same period. The adult condition of *Eudorina* or *Volvox* in other words is a permanent morphological equivalent of the blastula-stage in the ovum of a Metazoon, and a spermatocyst holds a similar relation to the encysted reproductive stage at the terminus of life in an Amœba. It, however, occurs at the beginning of life in this specialized male cell among Metazoa. The spermatozoa also, which are produced by fission of the nucleus, resemble the young of the Amœbinæ and many other Protozoa in form, but have, through earlier inheritance of characteristics, acquired the functional power of the adult male Protozoon, and are therefore, as compared with Protozoa, to be estimated morphologically and functionally as microgonids with highly concentrated development. In no other way can we account for the premature exhibition of power shown by these forms in seeking out the egg and forcing their way into the vitellus. Ultimate union with the female nucleus of the ovum by passage through the vitellus is quite distinct. It has appeared to us to be, like concrescence in low forms, an exhibition of mutual attraction which indicates affinity, and, like all sexual processes, a vital attraction of greater intensity than mere fusion by growth, and in no way attributable to accident. The habit may have sprung from the habit of concrescence, just as we can only imagine all sexual processes as springing originally from concrescence through its transformation into a habit preparatory to reproduction by division, as among Myxomycetes. Cienkowski considers concrescence to have originated from the habit of feeding, and the results of concrescence, reproduction by fission, as a function due to the same causes and having the same results as assimilation (Archiv mikr. Anat. vol. ix.).

There is a gradation in the stages of development of the ectoderm, endoderm, and mesenchyme in the sponges which shows they have retained the ancestral protozoonal characteristics in some cells more than in others. Thus the ectodermic cells in all the Porifera become permanently transformed into flat epithelial cells, losing their feeding-organs, the collars, and flagella; whereas the cells of the endoderm in some forms, such as the Ascones, probably never lose these organs at all, and in others lose them only transiently at certain stages, or

* For results of protection in producing concentration of development see "Genesis of *Planorbis* at Steinheim," Mem. Bost. Soc. Nat. Hist. I. Anniv. 1830–1880; Fossil Ceph., Mus. Comp. Zool., Proc. Amer. Assoc. Adv. Sci. vol. xxxii. p. 32; also Balfour's Comp. Embryol.

only locally on the walls of the archenteron in the intervals between the diverticula (primitive ampullæ) *.

In the mesenchyme of sponges the cells have been subjected to fewer changes, and they preserve their ancient amœboidal forms unaltered. The comparatively great change in the evolution of the group probably took place after the transfer of the principal seat of assimilation from the endoderm to the mesenchyme. This transfer possibly occurred during the genesis of Sycones and other higher forms.

The researches of Saville Kent among Protozoa have shown that the collar and flagellum are feeding-organs, and we must imagine them as having a similar meaning in the internal cavity of Ascones, the lowest forms of sponges.

When we consider the whole series of transformations of the ovum it becomes apparent that it is at first an autotemnon having the Amœba stage well and clearly developed. The ovum develops parallel with the spermatocyst through the period of division of the nucleus into two parts, the masculonucleus and the feminonucleus. We have tried, in common with some other authors, to show that the masculonucleus is probably thrown off in the polar globules during a process of agamic division of the nucleus, and that these are the homologues of the masculonuclei excluded from the spermatocyst after having been transformed into spermatozoa.

The remarkable essays of Professor Ed. Van Beneden on the bisexual nature of the nucleus are the only embryological writings which produce the proofs of this hypothesis in illustrated form. This author ("Fecond. Maturat. de l'Œuf," Archiv. de Biol. tom. vi. 1883) advances precisely similar views to those of Dr. Minot, and shows the phenomena of fecundation and the double composition of the maritonucleus in a series of remarkably clear illustrations. Van Beneden claims to be the discoverer of the bisexual composition of the nucleus of the ovum, and refers to his paper of December 1875 (Bull. Acad. de Belg. vol. xl. 1875) as containing the first statement of his discovery. Though not pretending to forestall the judgment of those better qualified to decide the merits of these claims, we find that Professor Van Beneden was the first to announce the basal facts of the bisexual theory, but that he did not give all of the essential conditions of the phenomena of conjugation between the male and female parts of the nuclei in his first

* Von Lendenfeld (Austral. Sponges, Proc. Linn. Soc. N. S. Wales, vol. ix. pl. iv.) describes *Homoderma sycandra* as having these cells equally distributed all over the endoderm as well as in the single ampullæ.

paper. This author, in the work just cited (p. 700), suggests that the peripheral pronucleus is probably partially formed of spermatic substance, that the central pronucleus is female, and that the segmentation-nucleus is a compound body resulting from the union of these two, and is therefore probably bisexual. This statement includes all the basal facts of the genoblastic theory, with, however, two important exceptions. It omits any notice of complementary behaviour or functions of the useless parts of nuclei in both the spermatocyst and ovum. This essential condition of the conjugation of the nuclei does not seem to have been elaborated by Van Beneden until 1883, long after the appearance of Dr. Minot's paper. Dr. Minot (Proc. Bost. Nat. Hist. vol. xix. p. 170) proposed to name the original bisexual nucleus "genoblast," the female part "arsenoblast," and the male "thelyblast," and these terms have precedence of those we have advanced, or of those proposed by Van Beneden; but we have preferred to use names which retain the word nucleus, as more expressive of the true relations of derivative nuclei.

If this is true the occurrence of this process of excluding the masculonuclei in the ovum during the agamic stage exhibits an earlier inheritance of a characteristic which in the Protozoa occurs only after and as a result of impregnation, except possibly in some of the more specialized Flagellata and Ciliata, where the existence of spermatocysts and spermatozoids leads one to anticipate a corresponding differentiation. The female zoön certainly appears to be in reality an ovum, and to develop like one into a blastula, as pointed out by Bütschli.

This view includes some results worthy of attention. The concrescence of Protozoons, as in cases cited by Drysdale and Dallinger, and in some plants where the whole contents of one pair of cells or more than one pair of cells are mingled together, is asexual conjugation, but not sexual conjugation. The latter occurs only by the exchange of differentiated parts of nuclei, or between the larva-like spermatozoa and the complementary part of the nucleus in the ovum. Thus such forms as *Eudorina* and *Volvox* might be called, on account of their morphology, Blastrea, and could, because of their mode of reproduction and the existence of but one layer in the body-wall, be appropriately designated as true Mesozoa.

With regard to the meaning of the early stages of the ovum we come nearer to Bütschli (Morph. Jahrb. 1884) than any other author, and regard his placula theory as opening a way far more promising than any so far proposed. This author, however, voluntarily rejected the aid of the sponges in his arguments, under the erroneous impression that they were

Protozoa, and holds an essentially distinct idea of what the placula is. The embryo of the Calcispongian is, according to our opinion, a single-layered placula or a monoplacula, and directly comparable with the undifferentiated flat colonies of Protozoa which are more primitive than the blastula form, and represent the simplest condition of an autotemnic colony of Protozoa, like *Desmarella* of Saville Kent, though not possessed of cilia at this stage, and therefore more nearly perhaps representing a mass of amœboid forms.

The formation of the apical or esoteric cells of the upper layer from the cells of the monoplacula transforms this stage into a diploplacula, the older or basal cells becoming our exoteric cells. True ectoblastic and endoblastic cells first appeared during the gastrula stage, and are supposed to be identical with the differentiated cells often found in the blastula and placula. But in both of these last they are in distinct association and correlate with distinct forms, and should be considered as simply exoteric and esoteric cells. They are not true ecto- or endoblasts until they assume the relations of an external and internal layer, as in the gastrula stage. The absence of the placula in many forms may be explained as due to concentration of development. The protected conditions under which the ovum originates make the constant retention of the placula unnecessary, and favour the earlier inheritance of the morula or mulberry stage; in fact any quickening of the processes of growth would bring about this change, and the morula stage is only a heaping up of cells into a more massive colonial growth. The rounded globular forms of the morula would thus replace the placula earlier in the life of the embryo, and occasion its disappearance in more highly specialized forms, as in the Carneospongia.

This theory is apparently very similar to that of Bütschli so far as relates to the origin of the placula, but differs in making the morula an important stage of the evolution of forms, and in insisting upon the placula as primitively monoplaculate and only secondarily diploplaculate. Bütschli's placula is in reality a later stage, a specialized flattened stage of an embryo Metazoon.

Bütschli points out the resemblances of the embryo of *Cucullanus*, *Rhabdonema*, and *Lumbricus* to the placula, and the apparently primitive mode of forming the segmentation-cavity in the latter by the separation of the two layers is also given in detail by him. Bütschli also considers the *Trichoplax adhærens* of Schultze as a living illustration of a full-grown, primitive, placulate form.

We ought to find primitive stages in the embryos of a

primitive type, and this is eminently the case with Porifera. We should anticipate the opposite with a higher type like the worms or any metameric animal, and this appears to be borne out by what Bütschli brings forward in support of his theory.

In *Cucullanus* the earliest stages are rounded, and we cannot agree with Bütschli that the flattened form which follows this is a primitive placula or diploplacula. The primitive placula is a single layer which becomes double or diploplaculate, and in both stages must precede the morula, and cannot succeed this stage. It will be seen by our remarks above that the esoteric and exoteric differentiations would have occurred normally before the morula stage in the placula of *Cucullanus* or else in fusion with it, and therefore the double-layered placula of Bütschli would be necessarily a flattened morula in which the two layers had already been formed. The relations of the planula stage in *Cucullanus* and *Lumbricus* to the gastrula also indicate that it is simply a modification of the morula stage, and not comparable with the earlier premorula stages of the embryo. The formation of the gastrula in *Cucullanus* is a beautiful example of extra growth of the ectoblast, as has been pointed out by Balfour; and in this and in *Lumbricus* a true embolic gastrula is formed by this process, which is not more primitive than that which occurs in the *Ctenophoræ* or *Tubulariæ.* The gastrula, in other words, is formed according to a highly concentrated secondary mode of development, and not by primitive or simple processes. We should therefore, even while adopting Bütschli's theory, decline to accept his typical examples as true illustrations of the theory, and hold rigidly to the law of succession in the stages of the embryo for justification of this position.

We cannot give a better illustration of what we mean by a monoplaculate embryo than Hatschek's *Amphioxus* in the four-celled stage *, nor of our diploplacula than the same in the eight-celled stage, when the cells of the esoteric layer are first differentiated, which occurs even before the two poles of the embryo become closed and long previous to the stage when the blastula is formed.

Immediately after the diploplaculate stage the ovum of Porifera and *Amphioxus*, as well as some other types, presents a stage during which it is a tube open at both ends. The hereditary significance of this stage indicates a tubular ancestral form, through which water would freely circulate; and

* Arbeit. d. Zool. Inst. d. Univ. Wien, iv. Heft i. pl. i.

this strengthens our position with regard to the meaning of the aula of the blastula.

The central cavity of the blastula stage, the so-called Protogaster of Häckel, connects with the exterior by a blastulapore, the "Protostoma" of Häckel, which is normally closed later in the growth, but remains open for long periods in some sponges, as may be observed in the figures of *Sycandra raphanus* and in the larvæ of siliceous sponges, as in the embryos of *Halichondria* and *Tethya*. The assumption that such a primitive cavity necessarily originated as a gastric cavity seems improbable.

The prototype of this cavity, the aula, must have first appeared as a central hollow in a moving colonial form of Protozoa, simply as a mechanical necessity of the habits and mode of growth, and might have been useful as a float; but was probably not a gastric cavity, but, on the contrary, similar in every way to the internal cavity of the *Volvox* blastula. The additional advantage of the possession of such a hollow in enabling the cells to use both sides instead of one, and to perform the functions of respiration, ingestion, and excretion more completely, is obvious. The growing of the cells of the ovum into a hollow sphere, the blastula with its blastulapore opening externally, is described by Bütschli as essentially similar to the growth of the adult floating spherical colonies of *Volvox* and *Eudorina* from a single zoön by fission. This author (Bronn's 'Thierreich,' Protozoa, pl. xlv.) gives a series of figures illustrating the development of the asexual zoöns of *Volvox* which fully substantiate his comparisons, and, together with Carter's, show that the closest comparisons may be made between the early stages of the ovum and those of all forms of *Volvox*, which is an open blastula like that of some Porifera before it leaves the parent colony and becomes free.

All of these comparisons seem to be much opposed to Bütschli's supposition that the primitive cavity of the blastula originated from a separation of two layers rather than as a stage of development from one primitive layer and the formation of an aula.

In order to account for the differentiation of the esoteric cells we have imagined them as necessarily by position feeding-cells in the ancestors of the diploplaculate stage. In the free morula and closed blastula the same cells or their more modified descendants would tend to retain similar functions. The differentiation of the poles would occur in this blastula form according to the same law as is observed in the higher animals, and the tendency already initiated of the zoöns of one pole to become exclusively feeding-zoöns would be

increased by more frequent contact with food and by being constantly occupied in the act of ingestion. The differentiation of the cells having been thus established and kept up by a continuance of similar habits, and the aula correlatively developed, we should have a free moving form with the cells at one pole feeding-cells, and at the other probably more efficient as respiratory cells. These last need not be necessarily inefficient as feeding-zoöns, but might have remained quite capable of this office as well also as that of developing flagella for moving the body, and, in fact, resembling in aspect and structure what we actually find in the amphiblastula of some sponges. We here claim for the exoteric or ectoblast cells that their possession of collars and flagella implies the existence of powers of ingestion. We think the negative evidence adduced by Metschnikoff and others with regard to these cells in the embryos of sponges is entirely inadequate to prove anything except the fact that they have not seen them actually feeding, and does not weigh against the observed functions of the collars and flagella of the Flagellata, especially the positive and convincing proofs brought forward by Saville Kent.

The parenchymula is a recently discovered stage of the embryo immediately succeeding the closed blastula. The esoteric cells differentiated during preceding stages have been found by several authors to quit the exterior, where they originated, and wander into the interior, where they presumably give rise to the endoblastic cells subsequently found there.

A differentiated colony, like the amphiblastula, with the cells at one end becoming better fitted to take in food, could be transformed into a parenchymula by the migration of differentiated feeding-cells into the interior, and the parenchymula could thus have been transformed into a true gastrula. There are no living forms, so far as we know, with which the parenchymula can be compared, and its probable meaning has already been indicated by other writers, especially by Metschnikoff, namely, that it implies a radical form in which the mesenchyme has arisen as a primitive mass by delamination.

The inwandering of the esoteric cells of the parenchymula might be reasonably assumed as in part due to pressure. This appears to be a primitive mode of forming the endoderm as stated by Schmidt and Metschnikoff, and therefore we should have to consider pressure as simply a possible cause aiding the tendency to inwandering, as it appears in the habits of these cells of the parenchymula. It is possible that this

tendency was derived from ancestors in which a primitive invagination appeared as a later characteristic of the development, due to excess of growth in peripheral parts, and that the same conditions of growth and pressure would continue to be present in the similar parts of the young of descendent forms as long as the surroundings and habits were sufficiently similar and did not interfere with hereditary tendencies. Thus we should have to regard the habit of inwandering of the esoteric cells as giving rise to the primitive endoblast, and this last as a permanent stage preceding the transient gastrula due to invagination. The continued action of the same cause as gave rise to the tendency to inwandering, namely the pressure occasioned by the rapid multiplication of external cells by growth, and the action of heredity, would secure this result.

The fact that the esoteric hemisphere is an excessive peripheral outgrowth of cells in the amphiblastula is in perfect accord with the successive stages in the development of pits and minor invaginations of the ectoderm. These are universally in their primitive stages peripheral outgrowths of the outer membranes, which form primitive hollows, and then these cups become hereditary invaginations in the embryos of descendent forms. The formation of stomodea and other ectodermic invaginations can thus be accounted for as in every way parallel to formation of the gastrula and due to similar causes.

The invagination of the endoblast in the ordinary form of the gastrula is immediately accompanied and caused, according to Whitman, by pressure arising from the unequal growth of the hemispheres. The pressure on the endoblast after invagination is shown by the forms of the cells, which become elongated along the middle part of the cup, as in the well-known case of *Amphioxus* described by Kowalevsky and many examples by other authors. The growth and excess of pressure is also evinced in the elongation of the planula and the tendency of the at first broad blastopore to close up to a narrow opening by growth of the ectoblast. The usually columnar aspect of the ectoblastic cells of the planula, their longest axes being radial or at right angles to the direction of the pressure, is also favourable to this theory. These cells may be attenuated in Porifera at this stage (Barrois, Époug. de la Manche), so as to assume an almost linear aspect under low powers of the microscope. We feel obliged to join those authors who regard the planula-stage as an abbreviated form of the gastrula possibly directly derived from the epibolic gastrula. The succession of the stages is first a peripheral

outgrowth, increasing continually the diameter of the amphiblastula, then invagination, then peripheral growth of the ectoblast, followed by elongation of the planula and contraction or obliteration of the blastopore. Heredity in these cases seems to be subordinate to growth; but this we think is due to the necessarily identical action of these inseparable forces. Heredity and growth are also necessary in order to account for cases of epibolic gastrulæ as well as for the existence of the planula. The action of heredity in the planula is obvious; but in the transitional epibolic gastrula the obvious mechanical action of growth still interferes with the clear perception of the influence of heredity. The growth of the ectoblast cells is so rapid in the last named that the endoblast cells become enclosed, as in the Ctenophoræ, and the gastrula is formed by a process much shorter than is usual in embryos of the embolic type.

In a planula we can see very clearly that some other force in addition to growth has been at work, and that, whether we adopt Lankester's hypothesis or some other, we are equally obliged to call in the aid of heredity in order to explain the hidden steps by which the embolic gastrula has been transformed into this concentrated form of development through the epibolic gastrula as an intermediate stage.

Keller (Anat. und Entwickel. einiger Spong. d. Mittelmeers, Basel, Georg, 1876) has given the fullest illustrated account of what we have, in common with Metschnikoff and Schultze, called the transient gastrula of the Calcispongiæ. A recent perusal of this interesting paper has suggested that there is probably no better field for the study of the effects of pressure upon cells than in these cases of transient invagination. It is possible that the invagination stage may be traceable directly to excess of growth in the ciliated cells and their subsequent evagination as outgrowths to the reversal of this process, and at any rate the field is a very promising one in this direction.

We have also noted in our original essay the probability that the medullary fold was primitively a stomodeal invagination due to extra growth, and we are able to quote in this connexion an observation of Dr. Hatschek's in addition to those of Kollmann and Gardiner.

Dr. Hatschek (Arb. Zool. Inst. Wien, vol. iv. 1881, pp. 45-48) attributes the origin of the primitive segments and other changes of form in the embryo of *Amphioxus* to the growth and energy of cells. He explains the origin of the medullary plate by differentiations in the cells caused by the extra growth of the neighbouring cells of the ectoderm,

and attributes the rise of the ends and final enclosure of the neural canal to lateral outgrowths due to the same cause *.

The general presence of the different forms of the gastrula, including the planula, indicates, as we have tried to show above, that Häckel was right in supposing that these stages indicated common ancestors for the whole animal kingdom. To this we have also joined the architroch of Lankester, imagining in common with this author a very ancient origin for the circles of cilia around the blastopore of the primitive gastrula-like ancestors of the Invertebrata.

The history of the structural transitions through which the layers of the body pass in their subsequent history sustains the view that the Porifera are the lowest type of Metazoa. The endoderm and ectoderm reach a highly differentiated stage and appear as flat epithelial membranes; but the middle layer remains a mesenchyme, containing, as stated by all authors, the reproductive bodies of both sexes. The appearance of spermatozoa and ova indifferently in the same animal shows that entire separation of the sexes does not take place so far as now known among the Porifera. It is not yet established that cross-fertilization occurs in any form, though there is as yet no ground for the positive assertion that it does not occur. The history of the early stages exhibits a larval form in which the interior is solid for a certain period and the mesenchyme plays a much more important rôle than in any other branch of the animal kingdom, as might be anticipated from the adult condition and importance of this layer in the morphology of the group.

We have also tried to show that the general morphology and development indicated the gradual evolution of series of forms from a type similar to Ascones, but without a skeleton, which we have considered directly comparable, as stated by Häckel, with the gastrula. During this evolution the mesenchyme became more and more important, and as a result of its thickening the habit of budding was more or less suppressed, so that the higher types must be considered as individuals with a highly plastic form, liable to excessive outgrowths, but not as branching Metazoons. The archenteron also remains persistent throughout life, gives rise to simple diverticula, or, in forms with thick mesenchyme, diverticula themselves form branching tubes.

The fact that no internal column or body-cavity is formed,

* See also His, 'Unsere Körperform,' 1875, pp. 60, 61, 83, and 178, who has essentially the same idea of the relations of growth of cells and development of organs.

in spite of the opportunity offered by the increasing thickness of the mesenchyme, is very significant. It is not yet established that the mesenchyme does receive some additions in course of its growth from the endoderm and ectoderm, but, so far as the histology is now understood, it is doubtful.

In other words the Porifera are intermediate with regard to structural composition between primitive larval individuals, like the free larvæ of all colonial types, and the differentiated colonies which arise from such primitive individuals after they become attached, as in the Hydrozoa. They contain all the elements necessary for the formation of complicated colonies; but in consequence of the less differentiation of the mesenchyme their primitive individuality is maintained and the processes of budding take place internally and externally without perfect correlation. That is, the exterior has outgrowths and so has the archenteron, but these are not strictly coincident and produce true buds only in forms with thin mesenchyme.

The evidence in favour of the opinion that the diverticula or ampullæ are strictly homologous with the archenteric diverticula of all other animals is very strong. The young have no diverticula until the ampullinula is formed, and this correlates with the absence of these organs in the adults of the lowest type, Ascones. These facts among sponges seem to be in accord with the history and development of the diverticula among Hydrozoa and Actinozoa, and lead to the conclusion that in all of these three types the diverticula are homoplastic organs, and not found in the lowest forms of these groups or in the early stages of development of the normal forms.

The considerations we have presented above have therefore a direct application to the results of the work done of late years by Semper, Dohrn, and others in tracing the origin of the Vertebrata to some worm-like type. The whole of this evidence hangs necessarily upon the probability that the somites of the embryo of *Amphioxus* imply descent from a segmented animal; whereas, if we are correct, exactly the opposite view may be considered as the more probable; and the very close comparisons made by Semper between what he considers homogenous organs and parts in Vertebrata and Vermes can only be considered as evidence of the production of homoplastic effects by means of similar modes of growth and the similar habits of elongated and necessarily bilateral animals.

We have objected to the theory that the Vertebrata may be considered as descended from a Cœlenterate ancestor, because the actinostome probably arose independently and very late

in the phylogenetic history of the Hydrozoa, and undoubtedly arose independently in the Porifera. A stomodeum as it appears in the ascula stage or in a sycon or ascon may be a single opening not due to invagination, merely an enlarged pore or outlet. The cloaca of the more specialized sponges is first an outgrowth of the peripheral parts which becomes inheritable and causes the appearance of the ectoderm as a lining layer extending to an indefinite depth into the interior. A stomodeum, also, does not exist in most of the Hydrozoa except in the primitive shape of an outgrowth, the hypostome, which is the homologue of the internal actinostome of the Actinozoa. These facts and the late stage at which it arises (in the Actinozoa during the gulinula stage) show us that, so far as these types are concerned, it is an independent and homoplastic organ in all of them.

There are no exact comparisons between the embryos of Ascidia and *Amphioxus* and those of the Invertebrata which seem to include any stages later than the planula. Those that have been traced between the mesoblastic somites indicate homoplastic organs, and seem to have no phylogenetic meaning so far as the whole of the Vertebrata are concerned. The distinct modes of development of the anterior invaginations of the Vertebrata show that they had a different origin from the anterior tube of the actinostome, and cannot be considered homogenous with that organ in the Cœlenterata. The medullary invagination is at first a stomodeum arising as a funnel around the blastopore, and then spreads forward in the shape of two folds, which subsequently form a tube, and it is probable that the notochordal tube and the lateral differentiations of the archenteron may have had a similar homoplastic simplicity of structure.

The development in Ascidia of the notochordal cells and muscle-cells from the walls of the archenteron invites the suggestion that no true diverticula exist in this type. That the lateral muscles might have arisen as entirely disconnected and more primitive structural elements than the cœlomata is shown by Kowalevsky's work on *Cassiopea* already quoted (Soc. Friends of Nat. Hist. &c. Moscow, pl. ii. figs. 10–13). In this Hydrozoon portions of the archenteric walls grow out and become directly converted into muscles, but no cœlom is formed.

The notochord may have primitively originated as a tube, but connexion with the hypophysis seems to be a necessary condition of this theory; and though this is highly probable, it is not proven. The homoplastic origin of the notochord, when explained in this way, agrees with the subsequent origin

of segmentation in the vertebræ, as suggested by Cope. These facts and agreements in theory render it highly probable that the whole phenomena of segmentation as shown in the distribution of the muscles themselves, the appendages, and internal organs, including even the primitive somites, may have arisen independently in the Vertebrata in response to the simple mechanical requirements of motion in elongated bodies. Herbert Spencer, in a treatise much neglected by naturalists (Princ. Biol., Amer. ed. 1871, vol. ii. p. 199), has clearly shown that the origin of the notochord and of segmentation of the vertebræ and muscles may be attributed to muscular strains, and our speculations, though entirely independent, cannot lay claim to any original merit.

Our results are similar to those of Häckel so far as they distinctly point to the gastrula and planula as the earliest stages which have a general genetic meaning for the Metazoa, and show that these indicate a stock-form for the whole of the Metazoa. The clear distinctions between the type-larval stages in different branches of the animal kingdom and the fact that the type-larval stages make their appearance invariably after the planula or gastrula, and never, under any conditions, break this natural succession, give strong support to this opinion.

It is possibly premature to say that no one type can be claimed to have descended from any other; but the Porifera, Hydrozoa, Actinozoa, and Vertebrata appear to us entirely independent of each other. It is also very suggestive that two so closely allied groups as the Actinozoa and Hydrozoa can be considered as homoplastic types, and that many examples have been brought forward by the author and Professor Cope * among Cephalopoda and Vertebrata, where smaller and more closely allied groups, orders, families, and genera show the same phenomena, and are plainly homoplastic with reference to the origin of many important characteristics of structure. These results sustain the opinion that homogenous characteristics are frequently so similar to purely homoplastic characteristics that it is not safe to consider any characteristics occurring in distinct groups as homogenous until their phylogenesis has been traced or their comparative embryology is fully understood.

The hypothesis of the common but independent origin of types is also supported by all collateral evidences. The results of palæontologic research have carried back the origin of

* Cope, who first pointed out these relations in the same sense as Lankester, used the terms "homologous" for homoplastic and "heterologous" for homogenous.

distinct types further and further every year. It is now established that there was an excessively sudden appearance of vast numbers of forms in the Cambrian, or perhaps earlier, as claimed by Professor Marcou and others.

We have applied this specific statement as a generalization to the history of smaller groups of fossils in several branches of the animal kingdom and in many formations, and have found that the sudden appearance of the smaller groups occurs according to the same law.

There is an obvious plasticity in the animals which first make their appearance in any unoccupied field, or at the beginning of any new formation, which reminds one of the plastic nature of the most generalized type of Metazoa, the existing Porifera. The generalized types, which always occur first in time, exhibit like sponges exceptional capacity for adaptation to the most varied requirements of the surroundings and all of the conditions of the new period or habitat by the rapid development of numbers of suitable and more highly specialized forms, species and genera.

The whole picture as presented by morphology, embryology, and palæontology favours the hypothesis we have previously advanced in other papers, namely that the early geologic history of animal life, like the early stages of development in the embryo, was a more highly concentrated and accelerated process in evolution than that which occurred at any subsequent period of the earth's history.

The history of the Porifera and higher Protozoa suggests also that the evolution of the Metazoa may have occurred more rapidly than we can now calculate. One of the great errors of the present day is the assumption that such changes and transitions occurred slowly and gradually; and it is evident that this assumption is based almost wholly upon investigation of the more highly specialized animals, in which the capacity for change may be reasonably considered as very much less than in their more generalized and embryonic ancestral forms.

XXIII.—*Preliminary Communication on some Investigations upon the Histological Structure of the Central Nervous System in the Ascidia and in* Myxine glutinosa. By Fridtjof Nansen *.

It is proposed in the following pages to give only a mere

* Translated by W. S. Dallas, F.L.S., from the 'Bergens Museums Aarsberetning for 1885,' pp. 55–78.

preliminary report upon some of the results at which I have arrived in the course of the investigations which I undertook last summer (June and July 1885) in Alverströmmen (near Bergen), at the expense of Joachim Friele's legacy, which by the liberality of the Direction of the Museum was granted to G. A. Hansen and myself. I will expressly call attention to the fact that these investigations are not completed, and that therefore, for the present, it will not be advisable to go more in detail into the subject; but as I believe that some of these results may be of general interest, I venture in the meanwhile to publish them in their imperfect form.

The results at which I arrived in my investigations upon the histological structure of the nervous system of the Myzostomata, and which I have described in my memoir upon the structure of this group of animals *, stood in so remarkable a manner in agreement with many of the characters which Prof. C. Golgi (of Pavia) has described in the central nervous system (brain and spinal cord) of man, that it became a matter of much interest to me to have investigated some groups of animals lying between these widely separated forms. With this object in view I turned to the group of Ascidia (so much a subject of dispute from a systematic point of view), with the nervous system of which I had previously occupied myself, and in which I expected to be able to find something of interest. In the next place I wished to examine some low vertebrate animal, and selected the hag-fish (*Myxine glutinosa*), of which I could obtain abundant material.

The points which it was of essential interest to have investigated were as follows:—

1. Does the fibrillar mass of the central nervous system consist of two constituents †—*a*, a fibrillar net, or, as I will call it for the sake of clearness, a *fibrillar web*, consisting of fine fibrillæ, which in their crooked and intricate course cross one another in every direction; and *b*, coarser *percurrent* "*nerve-cylinders*," which either traverse the whole fibrillar mass of the central nervous system, and thus connect its different parts with each other, or run out into peripheral nerves?

2. Have all the nerve-cells (whether unipolar or multipolar) only one real nervous process ("prolongation nerveux ou fonctionnel"), and can the nerve-cells be divided into the following two types:—*a*, first type, of which the nervous pro-

* "Bidrag til Myzostomernes Anatomi og Histologi," Bergens Museum, 1886.

† As described in the above-cited work on *Myzostoma*, p. 33.

cesses, after giving off small side-branches, pass directly into a peripheral nerve and form a peripheral cylinder; *b*, second type, in which the nervous processes divide up into small branches, which lose themselves in and contribute to form the fibrillar web?

3. Do the nerve-cylinders in the peripheral nerves consist of two kinds:—*a*, in the first place, of nerve-cylinders, which originate directly from nerve-cells and constitute continuations of the nervous processes of the latter; *b*, in the second place, of nerve-cylinders, which originate from the fibrillar net, and are produced by a union of many small branches?

4. Do certain nerve-cells send out their nervous processes directly into the peripheral nerves without their passing through the fibrillar mass of the central nervous system, and can nerve-cells occur in the course of the voluntary nerves?

5. What is the case of the primitive fibrillæ described by Hermann *, Hans Schultze †, and others? are these a really existent nerve-element, and how are they to be regarded?

6. In what relation do the nerve-elements of the Invertebrate animal stand to those of the Vertebrate? are the nerve-tubes ("tubes nerveux"), or, as I have called them, "nerve-cylinders," of the Invertebrate homologous with the "axis-cylinders" of the Vertebrate animal?

These are questions of no small importance which still wait for a satisfactory scientific solution. They are, however, questions the answers to which, at all events in part, still lie upon the limits of the range of modern microscopy, and, especially in what relates to the nervous system of Invertebrata, we have such great technical difficulties to contend with that we can only hope that for some time to come we shall probably have to content ourselves more or less with assumptions. The point is to find new and certain methods of investigation quite different from those which have hitherto been generally adopted.

My investigations to the present time can therefore make no claim to give a satisfactory solution of these questions; they must be regarded only as a tentative effort to climb over a hill, which certainly is not insurmountable, but which it will need severe labour to get right over.

Central Nervous System of the Ascidia.

The histological structure of the nervous system of the Ascidia has remained until quite recently as good as uninves-

* 'Das Centralnervensystem von *Hirudo medicinalis*:' Munich, 1875 (Prize essay).

† "Die fibrilläre Structur der Nervenelemente bei Wirbellosen," in Arch. f. mikr. Anat. Bd. xvi. 1879.

tigated; it was only within the last few years that some light was thrown upon it especially by the writings of Prof. E. van Beneden and Dr. C. Julin *, but it still remains very backward. The central nervous system consists of the *brain*, situated between the apertures of the mouth and the cloaca, from the posterior end of which there issues the dorsal ganglionic cord ("cordon ganglionnaire visceral ou dorsal") described by Van Beneden and Julin, which extends backwards past the cloacal aperture until it disappears in the neighbourhood of the liver †.

Hitherto it has been the brain that has particularly interested me. With it I have tried many different modes of treatment, but none has as yet given satisfactory results; of course, I have employed all the ordinary methods with osmic acid, chromic acid, bichromate of potash, bichloride of mercury, &c., as also staining with carmine, hæmatoxyline, aniline colours, &c., and I have further made trial of Golgi's method (with bichromate of potash and nitrate of silver), but without obtaining the desired results, so that it will now be my endeavour to find out new methods. Golgi, in his method, has found one which, as regards the Mammalia and the higher Vertebrata, furnishes images of such striking distinctness that we cannot wish for better; the point now is to discover a method which may give similar results in the case of the lower animals, and only then can we give any more satisfactory answers to the questions above formulated.

* C. Julin, "Rech. s. l'Organisation des Ascidies simples," in Arch. de Biol. tome ii. (1881), pp. 59–126; E. van Beneden et C. Julin, "Le système nerveux central des Ascidies adultes," in Arch. de Biol. tome v. (1884).

† My investigations of this cord have as yet been quite superficial; but it would appear as if it may have a somewhat different structure in the different species. In the species which I have especially examined (*Phallusia venosa*, *P. mentula*, *P. obliqua*, *Ascidia scabra*, *Corella parallelogramma*) it has only a small development: the ganglion-cells generally are slender, elongated (bipolar), and closely packed together; it is but seldom that they are of the size of those found by Van Beneden and Julin in the species of *Molgula* (*M. ampulloides*) investigated by them; further, it appears that their arrangement and position may differ considerably from what the above-mentioned naturalists found in *Molgula*. It was but rarely that one could perceive any tendency in the cells to an arrangement about a common central axis, towards which their processes were directed; on the other hand, in several species, at any rate, I have found two fibrillar cords running one on each side of the principal mass of the cells, by which means the cells therefore come to occupy the middle of the ganglionic cord, a position which, regarded superficially, might remind one of the position of the cells in the spinal cord of the Vertebrata. I believe that I have several times seen nerves going off from the ganglionic cord.

Here I shall only report what I think I have observed with regard to the minute structure of the brain of the Ascidia; with respect to the more topographical description I will refer to the memoirs by C. Julin and E. van Beneden, already cited.

1. I find the *fibrillar central mass* to consist of two constituents, just as already described in the Myzostomes (*l. c.* p. 33). In the first place, a *fibrillar web*. This web is diffused throughout the whole mass, and gives it, in section, that spongy appearance which led Leydig to imagine that the fibrillar mass, or, as he called it, the "Punktsubstanz," has a spongy structure. It consists, however, in my opinion, of fine fibrillæ, which are most intimately intermixed, so that they appear to be interwoven with each other, but, at any rate, in general, without anastomosing with each other in the manner recently described in the case of the Rhipidoglossa by Dr. Béla Haller *. It is in the settlement of these difficult points in the lower animals that we are specially brought to feel how far our modes of investigation are still from being sufficient. I have certainly seen nearly the same images that Dr. Haller describes, and when his drawings are compared with mine this will certainly be the impression; but I am afraid that what Dr. Haller describes and figures as a fibrillar, anastomosing network is in reality nothing of the kind, but is connective substance, or, as Leydig calls it, "spongioplasma," which, in my opinion †, encloses and isolates the individual fibrillæ, and does not, as Leydig thinks, extend as a spongy tissue throughout the whole mass. If we compare sections of the fibrillar central substance with transverse sections of peripheral nerves it must certainly be confessed that in appearance these resemble each other; in both we shall see a distinct reticular web, consisting apparently of anastomosing fibrillæ; the only difference is that in the divided nerve the meshes are considerably coarser. We know, however, that here an isolation really occurs, and that every mesh is in reality a divided tube of spongioplasma, which encloses a hyaloplasmatic cord, a "nerve-cylinder," which in its turn either originates from or at any rate (with but few exceptions) traverses the fibrillar central substance. If it is connected with that substance, I cannot see but that to a considerable extent it testifies in favour of the view that *the reticular web which one sees by the ordinary methods of preparation is in reality connective substance or "spongioplasma," which sur-*

* For his work see further on, p. 224.

† Just as I have already stated in the description of the nervous system of the Myzostomes (*l. c.*).

rounds the true nervous "hyaloplasmatic" fibrillæ, which are generally nearly uncoloured.

Besides the fibrillar web we also find in the fibrillar mass *percurrent nerve-cylinders*, which usually appear to start from ganglion-cells and run to peripheral nerves. These percurrent nerve-cylinders are, however, difficult to observe; they are certainly of greater calibre, but they generally become stained by the same process as the fibrillar network, and as their course is not always the same it is difficult to trace them far. For shorter distances, however, they may be traced, and there can be no doubt of their actual presence; we can even in some places perceive a tendency to the formation of bundles or larger cords of fibrils. Percurrent nerve-cylinders, the exclusive destination of which would be the establishment of a general communication, I have not been able to demonstrate with certainty in the brain, although there is every probability of their existence here also. In the dorsal ganglionic cord, however, I have unmistakably seen such.

The *nerve-cells* in the brain of the Ascidia are of the most different appearance and size. Those which especially strike the eye in a section through an Ascidian brain are those of the outer layer which surrounds the central fibrillar mass. The cells of this layer are divided by Van Beneden and Julin* into three categories. The smallest occur furthest in, in immediate contact with the fibrillar mass; the largest occur exclusively in the periphery of the organ, and those of medium size between these two. They say: "Tandis que les petites et les cellules ganglionnaires moyennes constituent autour de la masse ponctuée une couche continue nettement délimitée, les grandes cellules ne se rencontrent qu'en certains points . . . . ."

2. I find that this description applies pretty well, at least in its main features, to the species examined by me. We certainly find cells of all possible sizes from the smallest to the largest; but we shall always see that these last are generally situated outermost, while the smallest for the most part lie innermost. Among these cells I have found both multipolar and unipolar forms; but the latter are beyond comparison the most general; the large cells especially appear to be principally unipolar. Among all these cells of such different sizes in this outer layer I have found both forms of nervous processes represented; there are cells with processes which pass directly to form peripheral nerve-cylinders, and others with processes which divide up and lose themselves in

* *Loc. cit.* p. 332.

the fibrillar web. Hitherto I have been unable to find any constant difference in this respect between cells of different sizes.

Besides these cells in the peripheral layer surrounding the central fibrillar mass there is also another form of ganglion-cell, which occurs in the fibrillar mass itself. These are small multipolar cells with an ovate nucleus. Van Beneden and Julin have observed these cell-nuclei in sections; they have also stated that they were possibly of nervous nature, saying *: "Il s'agit probablement là de petites cellules nerveuses allongées dans le sens antéro-postérieur, unipolaires ou bipolaires, et disséminées dans la substance fibrillaire." I have examined these cells both in sections and by the aid of maceration; the latter method especially gave me the best results; and I find that there can be no doubt as to their truly nervous nature. They are small multipolar cells, generally at least tripolar, the form of which reminds us in no small degree of the three-cornered form of small cells in the brain of the Vertebrata; the processes which originate from their most pointed end are the nervous processes, and these I have often been able to trace very far, in macerated preparations I have even succeeded in isolating them for a long distance; but I have nowhere found any ramification. In sections I have often seen them directed towards the origin of the peripheral nerves; and I therefore regard it as in the highest degree probable that these small tripolar or multipolar cells belong, at all events for the most part, to the type of nerve-cells, the nervous prolongations of which go directly to form peripheral nerve-cylinders. In the other processes of these cells, which may therefore be said to correspond to "Deiler's protoplasma-processes," I have frequently been able to see ramifications.

In conclusion, with regard to this question of the form and the processes of the nerve-cells I will remark that it has appeared to me on two occasions that I could see true processes from cell-nuclei, prolongations which united themselves again with other smaller cells. This therefore would be something comparable with what Dr. Béla Haller has described in the Rhipidoglossa, in which he thinks he has found numerous nuclear processes of the most different forms. Of the actual nuclear nature of these processes, however, I feel by no means perfectly convinced; I am afraid that the images of such a nature which I have hitherto had before me in the Ascidia may be due to an optical illusion, and

* *Loc. cit.* p. 334.

remain for the present somewhat doubtful as to their actual presence.

If I now summarize my results with regard to the nerve-cells and their processes in the brain of the Ascidia, they prove to be in the fullest agreement with the results at which I arrived in the Myzostomes, and in their principal features also with results obtained by Dr. Béla Haller in the Rhipidoglossa, only I must point out that in the Ascidia I have not succeeded in demonstrating undoubted anastomoses between the processes of the different cells, such as Haller describes in the Rhipidoglossa.

3. As regards the origin of the nerve-cylinders, as my investigations hitherto have not been specially directed to this point, only this much can be said about it, that from what I have hitherto seen there appears here also to be an agreement with my earlier results in the Myzostomes. There would consequently exist two forms, one originating directly from nerve-cells, and one originating from the fibrillar web—therefore two forms just such as Golgi has demonstrated in man.

4. With respect to the fourth point, it is not difficult to observe nerve-cells situated near the origin of the peripheral nerves and emitting their processes directly into the peripheral nerves without first passing through the fibrillar central mass. I have also found, in the peripheral nerves even at a distance from the brain, nerve-cells which sent their nervous processes in a peripheral direction and not inwards towards the central organ. This is therefore a condition which stands in the most perfect agreement with the condition in the Myzostomes, and does not agree with Vignal's * (and Ranvier's) assumption of the non-existence of such cells in the voluntary nervous system. Whether side-branches are not given off from the nervous prolongations of these cells, by which they are connected with the central fibrillar web, I have not yet been able to ascertain, although it certainly appears to me to be probable.

As regards the sixth and seventh points, I will reserve my reference to them until later on, when it will be possible to go into the matter more in detail; for, in the first place, the investigations in this direction are still far from complete, and, secondly, a hasty description of them would lead only too easily to misconceptions.

Summing up the main points in the above superficial description of the Ascidian brain and comparing it with my

* Vignal, "Rech. histol. sur les centres nerveux de quelques invertébrés," in Arch. de Zool. Expér. sér. 2, tome i. (1883).

former description of the nervous system of the Myzostomes, it will be seen that we have here obtained a good confirmation of the results furnished by the latter. It may now be of interest to investigate how the conditions stand in the lowest forms of Vertebrata. Of these I have as yet properly investigated only the hag (*Myxine glutinosa*).

The Central Nervous System in the Hag (Myxine glutinosa).

Of this interesting animal it is easy, at Alverströmmen, to obtain abundant material; but the time was too short to allow any thorough investigation to be undertaken; during the coming summer I hope to have an opportunity of doing this, and it may even be expected that with new fresh material I may try new and better modes of investigation. Here therefore I will only express myself with extreme brevity.

So far as I know, no one has recently paid particular attention to the histological structure of the central nervous system of *Myxine*; on the other hand, something is known of the histology of the nervous system in the genus *Petromyzon*. In Dr. Ahlborn's memoir, "Untersuchungen über das Gehirn der Petromyzonten" *, there is a detailed description of the topography of the brain in *Petromyzon*, as also a portion of the histology of the brain and spinal cord; there will likewise be found in it a list of the earlier literature of the subject. Our histological knowledge of *Petromyzon* also is unfortunately rather defective, and there still remains much to be made out.

It appears that the structure of the nervous system in *Myxine* and *Petromyzon*, notwithstanding many differences, is on the whole tolerably accordant. It is especially to the spinal cord that I have hitherto directed my attention.

As is known, the *spinal cord* in *Myxine*, as in *Petromyzon*, has that flat band-like form which at once catches the eye in transverse sections. On the ventral surface there is a considerable longitudinal depression or groove, a kind of *sulcus longitudinalis ventralis*, if one may call it so; on the dorsal surface, on the contrary, there is no trace indicative of such a groove.

The space between the central canal and the ventral longitudinal furrow is occupied by a considerable markedly fibrillar mass of connective tissue, in which the fibrillæ from the two sides cross one another, and, at any rate for the greater part, are in connexion with the *pia mater* on both sides of the longitudinal furrow; a similar mass has also been described

* Zeitschr. für wiss. Zool. Bd. xxxix. (1883), pp. 191-294.

by Ahlborn in *Petromyzon*. The fibrillæ in this mass are partly processes from the epithelial cells of the central canal, partly processes from cells situated outside of these in the grey substance (see further on). On the dorsal side a thin septum of fibrillar tissue extends from the central canal to the *pia mater*. The fibrillæ in this septum consist, at any rate for the most part, of processes coming from the epithelial cells of the canal and from circumjacent cells. By these two septa or fibrillar masses the spinal cord is therefore divided into two lateral symmetrical parts.

The Grey Substance.—There is a considerable difference between the grey and the white substance. The former, in transverse section, has a broad and depressed form, corresponding to the external form of the spinal cord. A distinction of the anterior and posterior form is difficult to observe, and its actual existence can only be made out by careful investigation. In *Petromyzon* Ahlborn was unable to demonstrate the posterior horn. In *Myxine* I have found this possible, having been able, by means of different methods of staining, to trace the course of a great part of the fibrillæ which run to the posterior nerve-rods directly from the vicinity of the grey substance (see further on); it appears distinctly that the two small "horns," which Ahlborn has also observed in *Petromyzon*, and which are situated on each side close by the above-named septum, which goes off dorsally from the central canal, in reality correspond to a part of the posterior horn in the higher Vertebrata, inasmuch as the greater part of the fibrillæ passing to the posterior rods can always be seen to come from the white substance in the vicinity of these small horns, or the portions of the grey substance lying nearest on the outer side; exceptionally I have been able to trace fibrillæ quite from the small horns (probably originating directly from cells here) and quite to the posterior rods. In the anterior nerve-rods I have frequently been able to trace the fibrillæ quite from the ventral outer parts of the grey substance; but how much of the outer parts is to be referred to the anterior horn I am still unable to ascertain.

Just as in *Petromyzon*, the ganglion-cells in the grey substance may be of extremely different sizes. There are some which especially catch the eye by their remarkable magnitude; these are only few in number, and are regularly situated in the outer, more lateral part of the grey substance, and therefore essentially in the part which must chiefly be referred to the anterior horn. These cells, with their processes, generally stain very strongly, especially with various aniline colours (acid fuchsine, nigrosine, safranine, &c.). The smaller cells

are somewhat variable in size; they are distributed through the whole of the grey substance, occurring most numerously in its middle parts, the parts therefore which should be regarded as belonging to the posterior horn. These cells, with their processes, are generally less strongly coloured by staining fluids. To regard these different colour-reactions as indicating a constant difference from a physiological point of view, such as Bellonci * thinks he has demonstrated, and such as Ahlborn seems likewise inclined to assume in *Petromyzon*, appears to me to be still doubtful. It is certainly the case that the smaller cells which stain less strongly occur particularly in the middle portions pertaining to the dorsal nerve-rods, and therefore may be assumed to be especially sensitive; but I have also observed in the outer ventral parts similar cells which emitted their nerve-processes directly to the ventral nerve-rods, and as to the motor nature of which it seems to me therefore, in accordance with Golgi's work, there can be but little doubt; it must, however, be admitted that the cells here situated appear generally to have a tendency to become more strongly coloured than those placed in the middle part.

As regards the form of the ganglion-cells, they appear to be always multipolar, with pretty strongly branched protoplasmatic processes. I have frequently been able to trace these, with their ramifications, into the white substance; but whether they extend quite to the periphery of the spinal cord I have not hitherto been able to make out, although I believe I have often observed it. This is a point which it may be of interest, in connexion with the significance of these processes, to have cleared up; if the function of these processes be, as Golgi thinks and as seems to me probable, exclusively nutritive, we have here in *Myxine* the remarkable fact that no vascular system is present in the spinal cord.

I have only been able partially to trace the nervous processes; the processes especially which run to the ventral nerve-rods, and pass directly over to form the axis-cylinder, have been the easiest to observe; these processes therefore appear perfectly to agree with what Golgi has described, and, at any rate, to belong chiefly to "the anterior horn" and the ventral nerve-rods; nevertheless I believe that, as above stated, I have quite exceptionally observed similar ones in the posterior horn running to the dorsal nerve-rods. As a rule I have

* "Ricerche intorno all' intima tessitura del cervello dei Teleostei," in Atti d. R. Accad. d. Lincei, A. 276, 1878 (1879); and "Ricerche comparativa sui centri nervosi dei Vertebrati," in Atti d. R. Accad. d. Lincei, A. 277, 1879 (1880).

found it impossible to trace the nerve-processes in the posterior horn (therefore in the middle part of the grey substance)—just as the fibrillæ running to the dorsal nerve-rods can only be traced for longer or shorter distances, and only very rarely quite to the grey substance. This appears also to show an agreement with Golgi's description of the human spinal cord, and I must assume that the nerve-processes in this middle part of the grey substance (the posterior horn) at any rate for the most part divide up into small branches and lose themselves in the fibrillar web, from which again most of the fibrillæ in the dorsal nerve-rods originate; the correctness of this view, however, remains to be proved by more certain methods of investigation.

Besides the above-mentioned cells, a second kind of cell occurs in the grey substance. Similar cells have also been described by Ahlborn in *Petromyzon*. They appear, as that author also admits, not to be of nervous nature, but rather to belong to the connective substances; they are chiefly situated around the central canal, and perfectly agree in appearance and form with the epithelial cells in the epithelium surrounding the central canal. Each of these epithelial cells has a very long process, which is very easy to trace by suitable methods of treatment; I have even frequently been able to trace them quite to the periphery of the spinal cord; probably, indeed, this is the case with all these processes, so that they form connective fibrils radiating to the periphery. This appears indeed to be the general condition in the Vertebrata. Prof. Golgi long since found a similar condition in the fowl's embryo; I have myself seen his preparations, in which it was to be observed remarkably distinctly (he has, however, as yet published nothing on the subject). I have myself also recognized it in the spinal cord of the tench (*Tinca vulgaris*) which had been treated in accordance with Golgi's method. The cells situated outside of the central canal in *Myxine* have similar processes, and it is probable that these comport themselves in the same way. As previously stated, the connective tissue or supporting substance existing between the central canal and the ventral longitudinal furrow seems to consist of similar intercrossing fibrillæ. As will be stated further on, there occur everywhere in the white substance similar fibrillæ radiating from the grey substance to the periphery; it is also possible that all these come from similar cells situated in the grey substance, and that the whole primarily in the embryo originate from the epithelial cells surrounding the central canal.

The White Substance.—The general divisions of the white

substance into the *funiculus dorsalis* and *funiculus ventralis* and the *funiculus lateralis*, which Ahlborn also has employed in *Petromyzon*, I do not find to be really quite characteristic; but as they present several advantages for descriptive purposes, I will nevertheless retain them. The above-mentioned radial fibrillæ occur in the whole of the white substance, but they appear in the greatest number in its dorsal part, in the *funiculus dorsalis* and the dorsal parts of the *funiculus lateralis*, where their radial arrangement is also most easily observed. A grey granular mass, which Ahlborn * describes in *Petromyzon* as existing between the *pia mater* and the white substance, I have been absolutely unable to observe in *Myxine*; on the contrary, I have always been able distinctly to demonstrate the connexion of the radial fibres with the *pia mater*; and I assume that the same must also be the case in *Petromyzon* and that the grey mass which Ahlborn saw in his osmic-acid preparations was probably an artificial product, as he himself appears also to suppose. Between the radial fibres a network of fine fibrillæ is interwoven, which, in great part at any rate, must be regarded as of the same nature as the former, and therefore as belonging to the *connective substances*. Besides these parts belonging to the connective substances, we have also in the white substance the true nervous constituents. Of these what especially catch the eye in a transverse section of a spinal cord are the *coarse longitudinal fibres*, which occur especially in the ventral part, in the *funiculus ventralis*, and partly in the *funiculus lateralis*. These, which are the so-called "Müllerian fibres," were first described by Johannes Müller; there is, however, no other difference than size between them and the finer longitudinal fibres, and all possible transition-stages occur, from the very coarsest to the very finest. The coarsest longitudinal fibres are situated, together with others of smaller calibre also, in the *funiculus ventralis* on both sides of the ventral longitudinal furrow; they appear to be present in greater number than in *Petromyzon*, in which Ahlborn notes about eight coarser fibres; to give any definite number seems to me, however, to be quite arbitrary, seeing that, as already stated, there are all possible transitions, and therefore it is impossible to lay down any limits. Numerous longitudinal fibres likewise occur in the *funiculus lateralis*, especially in its more ventral parts; there are, however, only a few very coarse ones, and the calibre of the fibres diminishes

* *Loc. cit.* p. 245, note.

towards the dorsal surface *. In the *funiculus dorsalis* I have been unable to discover *any longitudinal fibres*, nor could Ahlborn do so in *Petromyzon*. This author, however, notes the possibility that the granules observed by him in the network may be divided fine longitudinal fibres; but this seems not very probable. I doubt the real existence of longitudinal fibres in this part of the spinal cord, and regard the nervous parts of the *funiculus dorsalis* as consisting exclusively of what I have previously called *the fibrillar web*, Golgi's "entrelacement nerveux diffus." This fibrillar web is also found distributed in the other parts of the white substance among the longitudinal fibres in both the *funiculus lateralis* and the *funiculus ventralis*; it is, however, most predominant in the more dorsal parts of the spinal cord, therefore, as stated, in the *funiculus dorsalis* and the *funiculus lateralis*, especially in the dorsal parts of the latter.

The Nerve-rods.—As already stated, I have often succeeded in tracing the fibrillæ passing to the ventral rods quite from the grey substance, nay, even from their origin from ganglion-cells; but I have found this possible only exceptionally with the dorsal nerve-rods. As regards a portion of the fibrillæ (those running most dorsally) at any rate I have been able to trace them for a tolerably long distance from their entrance into the dorsal nerve-rods; but there has always been a small space between them and the grey substance, in which they could no longer be traced, while in this neighbourhood they were also more diffused and divided up than towards the nerve-rods. From this I conclude, as already mentioned, that these nerve-fibres belong for the most part to the form which originates from the fibrillar web, while the fibrillæ running to the ventral nerve-rods principally originate from ganglion-cells. As regards their size, the dorsal nerve-rods seem to be considerably larger and to contain a good many more fibrillæ than the ventral nerve-rods, just as the field from which the fibrillæ for the dorsal rods originate is considerably larger than that from which the ventral fibrillæ spring.

* In transverse sections the longitudinal fibres always appear considerably wrinkled, so that a vacant space is formed around each of them, which, as Ahlborn has also noted in *Petromyzon*, indicates the original form of the fibres. In transverse sections the divided longitudinal fibre generally appears as a strongly-coloured mass upon the wall of this cavity. The elliptical transverse section of this cavity I have been unable to observe definitely as Ahlborn describes it; it appears to me generally to be nearly round; there are certainly many differences, but these I regard generally as artificially produced.

The Brain in *Myxine* I have as yet investigated only quite superficially, and therefore I will not at present enter upon any particular description of it. This much, however, may be said—the size of the nerve-cells appears to vary still more than in the spinal cord. There are very large cells which occur only in small numbers, and at the same time there are extremely small cells, which appear in very considerable numbers, especially in the anterior parts of the brain; in the cerebrum they are diffused quite uniformly throughout the whole mass. The large cells generally stain more strongly than the smaller ones; but this can be of no significance from a physiological point of view, as among both the larger and the smaller cells there seem to be cells of both the types described by Golgi, namely with processes which go directly to form peripheral "nerve-fibrillæ," and with processes which divide up in the fibrillar web, as is not difficult to demonstrate. In many preparations I believe quite definitely that I can see anastomoses between the protoplasmatic processes of different large nerve-cells; in spite of the most careful examination with homogeneous immersion-lenses (Zeiss $\frac{1}{18}$) I was unable to come to any other conclusion than that such anastomoses were present; nevertheless I will say nothing decided upon this point, and will still treat it as doubtful, until it is possible to make a more thorough examination of many preparations.

Conclusion.

If, after giving this certainly very superficial description of investigations upon the central nervous system in the Ascidia and *Myxine*, we bring together in conclusion the results which may be regarded as arrived at, and compare them with the seven different questions or propositions which we commenced by formulating, it must certainly be admitted that, omitting the last question, which has not been particularly treated of here, the others appear to have been pretty thoroughly confirmed, and the conditions found are in agreement both with what I have previously found in the Myzostomes and with what Prof. Golgi has ascertained in man and in the higher Vertebrata (Mammalia); it might therefore from this even now appear to be a probable supposition that these conditions occur throughout the whole animal kingdom, in which generally a more developed nervous system exists.

In passing I will call attention to an agreement between the above description of the spinal cord of *Myxine* and the

description previously given of the ventral cord of *Myzostoma*, an agreement to which I certainly will not ascribe great importance, but which has nevertheless struck me as remarkable and as, at any rate to a certain extent, indicative of a homology between the spinal cord and the ventral cord. As we have seen above, the nerve-fibres traversing the spinal cord longitudinally are essentially situated towards the ventral surface, while the fibrillar web appears especially on the dorsal side. In the ventral cord of *Myzostoma*, on the contrary, the fibrillæ which run longitudinally were situated on the dorsal side, while the mass of the fibrillar web constituted the ventral part of the ventral cord. Here also, especially, were situated the cells, the nervous processes of which divide up into the fibrillar web; while the cells which send their processes directly into the peripheral nerves belong essentially to the dorsal surface, therefore altogether exactly the opposite of what we found in *Myxine*. However, if we regard the ventral cord and the spinal cord as homologous, we must also imagine the ventral cord as turned with its dorsal surface downwards, that is to say the dorsal surface in *Myzostoma* corresponds to the ventral surface in *Myxine*, and *vice versâ*; and if we consider the above-mentioned conditions we shall find the most beautiful agreements. According to Dr. Haller's description it appears that in this respect a similar condition to that here mentioned in the Myzostomes occurs in the Rhipidoglossa. As already said, I will not from our present standpoint ascribe any greater significance to this; but it nevertheless seems to me to be possible that, when more thoroughly investigated, it may show itself to have a deeper foundation.

After these investigations were undertaken last summer at Alverströmmen, and at the same time that my memoir on the structure of the Myzostomes was printed in the winter, the very remarkable memoir by Dr. Béla Haller on the structure of the central nervous system in the Rhipidoglossa* appeared in the 'Morphologisches Jahrbuch,' in which that author has arrived at results which in many respects stand in striking agreement with those above detailed and with the results obtained in the case of the Myzostomes. This is certainly not the place to go in detail into this memoir; but I will state in a few words the points in which, from my investigations, I cannot perfectly agree with Dr. Haller.

He has, like myself, two forms of peripheral nerve-fibrillæ, some which originate directly from ganglion-cells and others

* "Untersuchungen über marine Rhipidoglossen," in Morphol. Jahrb. Bd. ii. 1885, pp. 321–436.

which originate from the "fibrillar net;" in the next place he has found two types of nerve-cells (such as Gerlach had previously supposed to occur in the spinal cord of the Vertebrata *), namely a type which sends its nervous process directly to a peripheral nerve, and a second type, the nervous processes or, at any rate, "processes" of which divide up in the fibrillar net †. The ramifications of this latter kind of processes, however, in Haller's opinion, form an actual reticular net; therefore they anastomose and form real meshes, which, as already pointed out, is in opposition to my conception of them. Then Dr. Haller, like Gerlach, thinks that the fibrillar net (or web, as I believe) is also formed by "non-nervous processes" of the ganglion-cells, and therefore by Deiter's "protoplasmatic processes," which, according to what has been above stated, is not in agreement with the results at which I have hitherto arrived. Dr. Haller did not know Prof. Golgi's very important investigations; according to these it seems to me to be made out that, at any rate in the higher Vertebrata, the fibrillar web is formed by the *nervous processes*, of which there are never more than one to each cell, and *not by the protoplasmatic processes*, which do not serve to connect the different ganglion-cells, but, in accordance with Golgi's opinion, exclusively have to do with the nutrition of the cells. Anastomoses or unions between the different ganglion-cells by their processes, which Haller describes as the regular condition in the Rhipidoglossa, I have been unable to demonstrate with certainty in the groups of animals investigated by me, at any rate as the rule. As regards the numerous nuclear processes described by him, I have been unable, as already stated, to convince myself positively of their existence from my preparations, although in many cases it has seemed to me probable.

These are the most important points in which, from a rapid perusal of Dr. Haller's important memoir, I do not think that I can agree with him; on the whole, however, his and my results may be said to confirm each other to a very considerable extent, and possibly we have thus advanced to a somewhat more solid basis for investigations upon this difficult subject. In a letter Dr. Haller has moreover informed me that he has met with the conditions described by him not only in the Mollusca, but also in the Chætopoda ‡ and in the

* J. Gerlach, "Von dem Rückenmark," in Strickker's 'Handbuch der Lehre von den Geweben' (Leipzig, 1872), p. 684.

† This kind of cells, however, Gerlach called "cells without nervous processes," therefore only with protoplasmatic processes.

‡ I have also, both in Polychæta and Oligochæta, met with conditions corresponding to those which I have described in the Myzostomes.

spinal cord of various Vertebrata, and he thinks that J. Gerlach's older important discoveries are in this way confirmed and extended, and that they may be admitted for all bilateral animals. Although I cannot quite agree with this as regards Gerlach's descriptions, it may nevertheless be assumed that here all turns upon the condition which, as I have above indicated, at any rate in its main features, occurs throughout the whole animal kingdom, in which, generally, a more developed nervous system is present. To discuss this matter in its minute details and to clear up the many doubtful points will be an affair of the future.

XXIV.—*On the Genus* Hindia *and its Species.*

By Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., &c.

Dr. H. Rauff has been so kind as to send me a copy of his paper "Ueber die Gattung *Hindia*, Dunc." (Separat-Abdruck aus den Sitzungsber. der niederrh. Gesellschaft zu Bonn, Mai 10, 1886). He has confirmed the truth of the diagnosis which I gave of the very beautiful species, and he admits the genus as correct. Dr. Rauff does more than this; he utterly demolishes Prof. Steinmann, who with "grosser Entschiedenheit" wrote that the *Hindia* was not a sponge and had neither oscule, canals, nor spicules! It is very pleasant to have one's battles fought by an able foreign naturalist, and Dr. Rauff has my sincere thanks.

The description of *Hindia* as a genus and of its species, *H. sphæroidalis*, was published in the Ann. & Mag. Nat. Hist. ser. 5, vol. iv. 1879, p. 84, pl. ix. It will be noticed (p. 91) that there are canals and that the spicules are tetraclade. The figures given were drawn from nature by A. S. Foord, and figs. 1 and 2 *b*, *e*, give exact representations of the tetraclade elements of the canals, which are also in part represented in fig. 4. Prof. Steinmann says that the canals and spicules do not exist, and it follows that if he is correct the author of the paper was romancing and the able artist was drawing from his imagination. The most charitable proceeding is to suppose that the professor has not seen the paper on *Hindia* and has not had the opportunity of examining the type, part of which is at Munich. It is perfectly proved by Dr. Rauff that the morphology of *Hindia* was correctly described, and it is not therefore necessary to pursue the

contest with Prof. Steinmann any further. But two points of considerable interest have been raised by Dr. Rauff and by my friend Dr. Hinde, who first of all brought the fossil under my notice.

Firstly, I called the species *Hindia sphæroidalis*, and described it so that Dr. Rauff had no difficulty in recognizing the form; the morphology of the species and its special characters were also given by me (Ann. & Mag. Nat. Hist. ser. 5, vol. iv. p. 91). But Dr. Hinde, in the admirable 'Catalogue of Fossil Sponges in the British Museum,' p. 57, 1883, replaces my name "*sphæroidalis*" by "*fibrosa*," and attributes the species to Ferd. Rœmer. I demur to this proceeding, and for the following reasons:—It is a rule in classification that a species, in order to be established, must be so described that other forms than the type can be recognized. Subsequently, however, the generic name may be altered, and the species always remains with the describer's name attached. Now Ferd. Rœmer, in his 'Silurian Fauna of W. Tennesse,' p. 20, described the form under consideration as *Calamopora fibrosa*, Goldf., and gave *Favosites fibrosa*, Lonsdale, as a synonym. He considered the form a coral, and I maintain that there is not a single sentence in the description, meagre as it is, that would lead any one to distinguish the form I described from New Brunswick as belonging to it. So far as my recollection carries me, I passed by Ferd. Rœmer's description and figures as not relating to the fossil I was then studying. Ferd. Rœmer not having properly and practically described the form he studied, and having placed it amongst the Corals, I do not consider his species of any value whatever.

I cannot agree therefore to have my specific name "*sphæroidalis*" replaced by the unrecognizable and imperfectly-described "*fibrosa*." I therefore restore the name I gave to the sponge, and cannot recognize *H. fibrosa*, F. Rœmer, sp. *Hindia sphæroidalis*, Dunc., is quite correct.

The second point refers to the original mineralogical condition of the New Brunswick specimen, and which Dr. Rauff has examined at Munich. The present mineralization of the tetraclade spicules is calcareous. Dr. Hinde (*op. cit.* p. 58) writes:—"The examples from New Brunswick, however, have had their original skeleton replaced by calcite; and this fact led Prof. Duncan to believe that they were originally calcareous, so that '*there must have been a former mimetic and calcareous group of Spongida.*'" The last part of the sentence is of course from my work.

It was not, however, the calcareous nature of the spicules

which alone led me to the expression of the belief in the original calcareous condition of the skeleton; it was the discovery of a penetrating, parasitic, unicellular, vegetable organism within the canals and traversing the spicules which led mainly to the belief. Dr. Rauff mentions this *Palæachlya*, and notices correctly that it influenced my opinion that the skeleton was not siliceous in the living state.

But whilst he came to satisfactory conclusions regarding Prof. Steinmann in a perfectly scientific manner, my fellow-labourer considered the *Palæachlya* a *quantité négligeable*.

I venture to refer any body who may take an interest in this discussion to read the papers on the subject of the perforating parasitic Thallophytes recent and fossil (Proc. Royal Soc. 1876, no. 174, p. 238; and Quart. Journ. Geol. Soc. 1876, p. 205); also a communication to the Royal Microscopical Society, 1881, on the cavities within siliceous sponge-spicules, the result of vegetable organisms (Journ. Royal Microsc. Soc. ser. 2, vol. i. p. 557).

No long tubular vegetable structures with organs of reproduction have ever been found ramifying in siliceous skeletons, and the resemblance of the parasitic organisms of the Silurian, Devonian, and subsequent geological ages (found in calcareous fossils) to those in the shells of Mollusca, Corals, and Foraminifera of the present day is most remarkable. The penetrating Thallophytes of the present day belong to the same group as the ancient ones, and they are and were dependent upon the organic matter (connective tissue) which is within the calcareous structures of Mollusca, Corals, &c.

I maintain that the *Palæachlya* grew and lived in the sponge as it did in the corals of the same age, and that it was not introduced after fossilization. It was the presence of these tubular forms of many sizes within the calcareous element, as well as free in the canals of the *Hindia*, that made me believe the original skeleton was calcareous, not, as Dr. Hinde puts it, because the calcareous element now exists.

Fully appreciating Dr. Hinde's excellent work, and acknowledging the force of the arguments he has adduced to prove the occurrence of calcite after silica, I nevertheless must consider the argument I have brought forward to be of importance. Of course the statement that the mimetic series of calcareous sponges once existed, is within reasonable distance of the truth, for who amongst us is to limit Nature as regards possibilities? (Specimens of *Hindia sphæroidalis*, nobis, are now in the British Museum, and are portions of the type.)

XXV.—*Contributions to the Study of the Littoral Fauna of the Anglo-Norman Islands (Jersey, Guernsey, Herm, and Sark).* By Dr. R. Kœhler*.

[Plate XI.]

The Anglo-Norman islands (Channel Islands) are situated a few leagues from the French coast, to the west of the peninsula of the Cotentin. The most important of these are Guernsey, Jersey, and Alderney (Aurigny), to which may be added three smaller islands, situated not far from Guernsey—Sark, Herm, and Jethou, the Ecrehous to the east of Jersey, and a number of small islets grouped around Guernsey and which are inhabited.

I have passed two successive summers, in 1884 and 1885, in the Channel Islands. The first year I resided in Jersey and studied the fauna of that island, and, to a less extent, that of Guernsey and Sark. The following year I took up my abode in Guernsey, to continue the investigations which had only been sketched out the preceding year and to thoroughly explore Herm, which I was unable to visit in 1884.

The observations of which I shall give an account in this memoir are chiefly the result of researches carried on upon the shores at low water. During my first sojourn in the English islands in 1884 I made several dredgings and pelagic fishings, but in 1885 I preferred to devote all my time to researches on the shore; moreover I was unable to find in Guernsey a fisherman who possessed a dredge fulfilling my requirements. I have, however, carefully noted some species brought to me by the fishermen, which were obtained by dredgings made off the south-east point of Guernsey.

I did not wish (and indeed it would have been impossible for me) to pay attention to all the groups of animals which together constitute the marine fauna of Jersey. In the first place I discarded the fishes. Their study, and especially their preservation, necessitate a quantity of encumbering materials with which I could not think of loading myself. I have also paid comparatively little attention to the Mollusca. A list of the species found at Jersey has been published by M. Duprey in two notes inserted in the 'Annals and Magazine of Natural History.' I therefore omitted entirely the study of the Mollusca of Jersey, judging that I should not find anything to do after the researches of M. Duprey, who has for a very

* Translated by W. S. Dallas, F.L.S., from the 'Annales des Sciences Naturelles,' sér. vi. tome xx. pp. 62.

long time paid attention to those animals. But at Guernsey and Herm I shall indicate some interesting species which have not yet been found at Jersey.

In this memoir, therefore, I evidently cannot pretend to present an exact and complete picture of the fauna of the Anglo-Norman islands. But I have determined to publish these observations, incomplete as they may be—in the first place, because no one has ever made known the fauna of these islands in a satisfactory manner (the only list of animals which has been published is in the work of Ansted and Latham, and is too fanciful (*fantaisiste*) to be of any use to zoologists), and, secondly, because works upon local faunas are rather rare, especially in France, in consequence of which we know the fauna of our coasts on the Channel and the Atlantic only in a very imperfect manner. Works of this kind, when they are isolated, evidently possess only a purely local interest; but a collection of works treating of the fauna of distinct regions, and in which one can compare, on the one hand, the list of the animals found at a given point, and, on the other, the nature of the ground, the geological constitution of the soil, the marine currents, the temperature, and in general all the factors which influence the geographical distribution of animals, such a collection of works would possess great interest. It is to be hoped that now, when all the young zoologists make a point of going to work on the sea-coasts, our shores of the Channel and Atlantic will by degrees be explored in detail. Every one must see the interest attaching to these works of pure zoology, and they are now of absolute necessity.

Before commencing the exposition of the fauna of the Channel Islands I have an important remark to make. As may be seen by running through the list of species which I have collected during my travels, the fauna of these islands includes a great number of distinct forms. But it has seemed to me that, while the species are pretty numerous, on the other hand the representatives of any given species are much less so, and as regards the *number of specimens* the fauna is comparatively poor. There are evidently a certain number of species which are common everywhere and which must not be taken into account when we wish to take a general view of the fauna of a locality. Of course I except certain exceptionally rich stations, where the species are very varied and represented by numerous individuals, as in the caves of Sark and the shell-sand of Herm *.

* I was fortunate enough to meet at Jersey a man who has occupied himself for several years with the study of marine animals—Mr. Sinel,

JERSEY.

The island of Jersey, situated at a distance of $12\frac{1}{2}$ miles from Portbail, has the form of a parallelogram with its borders irregular and pretty deeply cut. Its greatest length, from the south-eastern extremity to the north-east point, that is to say from the Pointe de la Rocque to Cape Gros-Nez, is 12 miles, from Corbières Point to the Pointe de la Coupe, which are the extremities of the other diagonal, the distance is a little less. Its width varies between $4\frac{1}{2}$ and $6\frac{1}{4}$ miles, the island being wider at the two extremities than in the middle, where it is deeply excavated by St. Aubin's Bay.

The island of Jersey slopes from the north to the south and south-east. The northern region in fact attains an elevation of 200–270 feet above the level of the sea, and in proportion as we depart from the north coast to descend towards the south we find the altitude regularly diminish, especially in the southern and south-eastern regions, where the ground, which is not much elevated, is continuous with the extensive sands of the bays of St. Aubin, St. Clement, and Grouville, whilst to the south-west the coast is more elevated and forms some escarpments between Sainte-Brelade and Corbières Point.

The island of Jersey is composed of very various ancient rocks, the study of which is of much interest, and which are known to us thanks to an already old memoir by Transon * and especially to a very recent paper by M. de Lapparent †. "The most ancient stratified rock in the island," says M. de Lapparent, "is a schistose grauwacke, often very hard, which occupies the central part of Jersey, and which is surrounded by three *massifs* of a granitic rock which authors have called syenite. This rock, composed of reddish felspar, vitreous quartz, and partially decomposed greenish mica, often becomes

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who has established a natural-history repository at St. Helier, and knows the shores of the island very well; he has given me valuable information which has certainly saved me a very considerable loss of time. I am very grateful to Mr. Sinel for the indications he gave me, thanks to which my investigations were rendered easier, since I was able to profit by the experience which he has been acquiring for several years; the remarks which I have been able to make upon the absence, the presence, and the distribution of certain species thus acquire a greater value than if I had been left entirely to my own resources.

* "Description géologique de l'île de Jersey," in Annales des Mines, 4e série, tome xx. p. 501.

† "Notes sur les roches éruptives de Jersey," in Bull. Soc. Géol. Fr. 3e série, tome xii. p. 284.

porphyroidal by the development of large crystals of orthose. A remarkable fact is the tendency of the quartz to acquire a granulitic appearance. From this result *massifs* or veins of a granulite with very black and rather scarce mica, the most distinct exposure of which is that observed near Mont Mado, in the form of a band accompanied by quartzose veins with sulphide of molybdenum." At those points where the syenite does not come to the surface it is covered either by *diluvium*, as in the greater part of the centre of the island, or by argillaceous schists, as in the region of St. Aubin's Bay, or again by petro-siliceous porphyries, conglomerates, and melaphyres, as is the case in the north and north-east of the island.

St. Helier, the capital of the island, situated in the valley of St. Sauveur, extends in a westerly direction along the most eastern region of St. Aubin's Bay, and terminates towards the south and east against a steep ridge about 160 feet high, called Town Hill. Starting from Town Hill the coast, which is quite low, runs at first towards the east and then bends a little towards the south as far as the Witches rock; it then resumes its easterly direction as far as the Pointe de la Rocque, presenting a shallow but very wide concavity which forms St. Clement's Bay. Throughout this space between Town Hill and the Pointe de la Rocque the coast is lowest; here the retiring sea lays bare an immense extent of sands bestrewn with rocks and becoming wider as we approach La Rocque, the whole of which forms the Banc de Violet. The different regions of these sands and rocks have received special names. First comes the Havre des Pas, commencing at Town Hill and bounded on the west by a series of rocks facing Elizabeth Castle, from which they are separated by a deep gulf; the most advanced of these rocks is the Dog-Nest. It is in the Havre des Pas that very large specimens of *Carcinus mænas* are often taken, whence the name of "Crabière" given by the inhabitants to this portion of the coast. This station is pretty rich; a very rare crustacean, *Achæus Cranchii*, Leach, is found in it.

Following the Havre des Pas comes the Grève d'Azette, sprinkled with rocks, the most important of which form the masses called La Ronde and Le Croc, near the coast, the Rocher-blanc and the Sambue, situated at the limit of the lowest tides, and lastly La Mothe, which separates the Grève d'Azette from St. Clement's Bay.

The Grève d'Azette, with the vast extent of ground which is uncovered to the south-east of La Rocque, is the richest station in the island. The sea in retiring forms numerous shallow pools, presenting a strong vegetation of *Zosteræ* and

surrounded by rocks clothed with an abundant covering of Algæ, often enclosing small natural grottos, which give shelter to interesting animals. At certain points, where the ground is sloping, little streams are produced, carrying off the excess of water from the higher parts, and it is in these streams that we can make the best collections of Bryozoa, Compound Ascidia, Hydroids, and some kinds of Sponges; near the banks the current is less rapid, and interesting Annelides may be collected under stones (such as *Lagisca propinqua*, *Polynoë squamata*, *Phyllodoce laminosa*, *Nephthys longisetosa*, *Aonia foliacea*, *Nereis Marioni*, &c.). Certain stations, such as the northern margin of the rock "La Ronde," where *Tethya lyncurium* is abundant, the neighbourhood of the rock "Pic-Triple," the vicinity of La Mothe, and the Sambue, deserve to be particularly indicated. It is near La Mothe that I captured several specimens of a very rare marine Hemipterous insect, *Æpophilus Bonnairei*, which is associated with a beetle, *Æpus Robinii*.

Following the Grève d'Azette comes St. Clement's Bay, the general aspect of which is the same as that of the Grève d'Azette; but the rocks, being more exposed to the winds, are less covered with Algæ, and the pools which are formed at low water are not so numerous as in the former locality. In St. Clement's Bay I have collected nearly all the species which I found on the Grève d'Azette, but at the cost of more laborious researches. On the whole the fauna is rather poor.

The next region, on the contrary, is much richer. It is the triangular space left uncovered at low water, the apex of which is La Rocque, while the base extends from the Conchière to well beyond Seymour Point. The region of which the exploration was especially profitable to me is comprised between La Rocque, Seymour Point, and the tower of the same name, as also between the last and Karamé.

At this point there is, in fact, a thick layer of mud, partly covered with *Zosteræ*, in which live a certain number of fossorial Crustacea which hollow out burrows in it (*Callianassa*, *Gebia*, and *Axius*), as well as many interesting worms belonging to the genera *Valencia*, *Marphysa*, *Clymene*, *Petaloproctus*, *Phascolosoma*, &c. In those parts which are not muddy the fauna is nearly the same as on the Grève d'Azette; some species, however, appear more abundantly than at other points, such as *Portunus puber* and *P. pusillus*, *Pisa tetraodon*, *Maia squinado*, *Xantho rivulosa*, *Pagurus*, &c. The Echinodermata are represented by numerous specimens of *Ophiothrix fragilis* and a few of *Asterias glacialis* and *Cribrella oculata*; Mr. Sinel has found one or two Holo-

thurians (*Cucumaria*) and once a *Spatangus*, probably thrown up by a gust of wind. At certain points the beach, covered with fine and shelly sands, presents numerous specimens of Molgulæ (*Anurella roscovita*). La Rocque is also a very good station for Mollusca (*Pholas dactylus* is sometimes met with there).

From La Rocque to the Pointe de la Coupe the coast offers no point of interest as regards the fauna, which is excessively poor. We have in the first place the immense bay of Grouville, stretching from La Rocque to Gorey, where the sea leaves bare an immense uniform beach, presenting hardly any naked rocks, and containing only a few very common Annelides. The same conditions recur to the north of Gorey in the bays of St. Cathérine and Fliquet.

The whole of the portion of coast included between St. Helier and Gorey is almost exclusively formed of syenite, which, at certain points in St. Clement's Bay, is replaced by diorite. The geological constitution of the rocks changes on leaving Gorey; we meet, in fact, with chocolate-brown petrosiliceous porphyries, which pass into pyromeride. These brown portions are known in Jersey as *rhyolites*. At the same time that the syenite disappears we see the coast gradually rise and present escarpments, which become more and more elevated as we approach the Pointe de la Coupe.

The southern region of the island presents, to the west of St. Helier, two deep bays, the first and most extensive of which is St. Aubin's Bay, and the other, smaller one, separated from the preceding by a promontory which is terminated by the Pointe de Noirmont, is the bay of St. Brelade. To the west of the port of St. Helier, and opposite to its entrance, is Elizabeth Castle, situated upon a rock rather more than half a mile from the town. To the south of the castle are some rocks forming the Hermitage. Between the castle and the port there appear a series of small rocky islets, which are all laid bare at low water and which sometimes give shelter to interesting types. Thus one of these rocks, situated close to the entrance of the port, harbours *Stenorhynchus ægyptius*, a new crustacean for the Channel. The rocks forming the *massif* of the chateau are not very elevated towards the north, that is to say towards St. Helier, but rise higher on the other side, where they plunge perpendicularly into the sea. They are formed, according to M. de Lapparent, of a granitoid diabase of very beautiful grain, united with a rose-coloured granite, of which it encloses angular fragments.

At the foot of the castle, between the fort and St. Helier,

there are muddy sands in which live numerous Annelides, common enough elsewhere:—*Cirratulus Lamarckii*, *Terebella conchilega*, *Nephthys Hombergii*, *Arenicola piscatorum* and *A. ecaudata*. *Synaptæ* are very frequent there. At this station I have also collected numerous examples of *Corystes cassivelaunus*. The fishermen come to this locality to collect Solens, which are very abundant there.

To the west of the castle there are meadows of *Zostera*, abounding in species of *Mysis* associated with *Themisto brevispinosus*, *Gastrosaccus sanctus*, and other Cumaceæ, *Idotea linearis* and *acuminata*, *Eolis Cuvieri*, *Doris Johnstonii*, *D. tuberculata* and *D. flammula*, *Triopa claviger*, &c. The *Aplysiæ* are very abundant here in certain years. Towards the south the sands become less muddy, and are replaced by gravels rich in fragments of shells, and in which Molgulæ (*Anurella roscovita*) abound. There we also find *Pirimela denticulata*.

The rocks, especially at the Hermitage, are covered with tufts of *Cynthia rustica*, under which live numerous species of crustaceans and worms; we also find here *Ascidia producta*, *Ascidiella scabra*, *Cynthia granulata*, and several species of Sponges (*Leuconia nivea*, *Dictyocylindrus ramosus*, *Halichondria incrustans*, *Isodictya cinerea*, &c.).

As to the rest of St. Aubin's Bay, the sea there, in retiring, lays bare an immense uniform sandy beach, possessing no interest for the zoologist, who will only find in it some very common Annelides and *Synaptæ*.

At the other extremity of the bay, opposite the little town of St. Aubin, some rocks appear, one of which bears an old castle. The Algæ which cover the stones contain some interesting Crustacea:—*Idotea linearis*, *I. acuminata*, and *I. tricuspidata*, *Atylus Swammerdamii*, *Podocerus falcatus*, and *Anonyx Edwardsii*. I have also met with a *Doris Johnstonii*, and some Tunicata (*Ascidia mentula* and *A. producta*, *Ciona intestinalis*, *Amaroucium Nordmanni* and *A. albicans*, *Didemnum sargassicola*, &c.).

Quitting St. Aubin the coast rises and the rocks become rather scarped as far as the Corbières, except in the Bay of St. Brelade. The bottom of this bay slopes very little, but it possesses no interest for the zoologist, as the fauna is null.

The western coast of the island from the Corbières to Cape Gros-Nez is occupied by a long, uniform, sandy beach—the Bay of St. Ouen. All the bottom of this bay is arid and dry, and the collections which I have made there are insignificant.

As to the north coast of Jersey it presents almost throughout its whole length a series of escarpments, and is bounded

by a high rocky perpendicular barrier. It presents a series of little bays in which the sea leaves bare sandy beaches of very small extent. Throughout this coast the fauna is very poor. Upon the rocks, which are too much beaten by the waves, *Balani*, *Patellæ*, and *Littorinæ* can hardly cling, and the sandy beaches shelter only a few very common Annelides.

From this description of the shores of Jersey it will be seen that it is especially and almost exclusively the south and south-east regions of the coast that will be explored with profit by the zoologist. The eastern and western coasts, at low water, only present uniform sandy beaches, the fauna of which is greatly reduced or almost null. As to the northern shores they are not uncovered.

From the St. Aubin Castle to and beyond La Rocque the exposure at low water is very extensive, except at the level of the ridge of the Town Hill, which divides into two regions this immense extent of ground, which is so largely uncovered—one situated to the west of a line passing from the Town Hill to Elizabeth Castle, a not very interesting region on the whole; the other situated on the other side of the above line and containing a varied and rich fauna. This latter region, moreover, throughout its whole extent, presents the same aspect and the same fauna. Except the band of mud which extends before La Rocque in a south-easterly direction, and which contains some peculiar species, all the rest of the Banc de Violet is occupied by numerous rocks of syenite covered by a rich vegetation of Algæ, in the midst of which there are formed at low water a great number of pools, having their bottoms occupied either by gravels or by meadows of *Zostera*. In order to describe the fauna of Jersey, therefore, it is not necessary to establish distinctions between the different regions explored, distinctions which would be founded, if requisite, upon differences of fauna.

Sponges.

I have collected in Jersey a considerable number of species of Sponges; but a certain number of them I have hitherto found it impossible to determine.

Among the Calcareous Sponges it is scarcely necessary to cite *Sycon ciliatum*, Häck., an extremely common species. *Leucosolenia botrylloides*, Bow., is pretty common among the *Zosteræ*, and *Grantia compressa*, Flem., is met with occasionally at Elizabeth Castle, where we also find *Dictyocylindrus ramosus*, Bow., under rocks covered with *Cynthia rustica*. On days of spring-tide fine specimens of *Tethya lyncu-*

rium, Johnst., may be collected in great abundance at the Grève d'Azette, and some examples of *Caminus osculosus*, Gr., at the Dog-Nest. *Microcionia armata*, Bow., and *Hymeniacidon armatura*, Bow., are sometimes met with upon *Pecten*-shells; the former species is more scarce and only lives upon specimens brought up by the dredge. *Halichondria panicea*, Johnst., is a sponge easy to recognize, which covers the rocks with broad green or yellowish expansions. *Hymeniacidon celata*, Bow., occurs frequently between the lamellæ of empty oyster-shells. *Hymeniacidon caruncula*, Bow., *H. mammeata*, Bow., *Isodictya fucorum*, Bow., *I. parasitica*, Bow., and *I. simulans*, Bow., are all common species at Jersey. *Isodictya cinerea* is much more rare. Another generally distributed sponge forms thin layers, which are difficult to detach, upon the surface of the rocks; it is easily recognizable by its fine rose-colour, and is perhaps identical with *Verongia rosea*, found by Barrois at Saint-Waast. Lastly, I doubtfully refer to *Dysidea fragilis*, Bow., some sponges which live upon certain specimens of *Pisa Gibbsii* and *Inachus dorhynchus*.

Cœlenterata.

There is nothing peculiar in the Actinian fauna of Jersey, and the types met with are the same that are found upon all our coasts. *Anemonia sulcata*, Penn., and *Actinia equina*, Linn., are very generally distributed. At Elizabeth Castle the rocks are covered with *Actinia equina*, all the specimens of which are of a uniform blackish-olive colour. *Tealia crassicornis*, Th., is often associated with the two preceding species, but always subordinate to them in number. *Bunodes gemmacea*, Gosse, occurs in abundance in the little shallow pools of which the bottom is occupied by gravel. In the same stations *Sagartia parasitica*, Couch, occurs attached to the shells in which the hermit-crabs take shelter, and the margins of which always bear a rich garniture of *Hydractinia echinata* and *Sagartia bellis*, Gosse, which is also sometimes met with fixed upon the rocks. We also find, but rather rarely, *Sagartia troglodytes*, Gosse. I once found two specimens of a small white *Actinia* attached to the rocks at Elizabeth Castle, which I have not been able to distinguish from *Sagartia sphyrodeta*, var. *candida* of Gosse. *Edwardsia callimorpha*, Gosse, is tolerably common in slightly muddy gravels, and I have found several specimens of it at Elizabeth Castle.

Lastly, to conclude the enumeration of the Actiniæ of Jersey, I will mention *Adamsia palliata*, Bodd., which never

quits a certain depth, and is common in St. Aubin's Bay, attached to the shells of *Buccinum* in which *Eupagurus Prideauxii* resides.

Echinodermata.

This is one of the worst represented divisions at Jersey; at least the specimens that one can find on the shore are few in number and belong to but slightly varied types. Thus I have never met with a single Echinid, and Mr. Sinel told me he had never met with any, even at the time of the highest tides. But with the dredge, in St. Aubin's Bay, some examples of *Strongylocentrotus lividus*, Brandt, and *Sphærechinus granularis*, Ag., may be captured. One day, with a high tide, Mr. Sinel found a *Spatangus purpureus*, Müll., at La Rocque. It is to be supposed that this animal was thrown up upon the shore by the waves.

Ophiothrix fragilis, Müll., and *Ophiocoma neglecta*, Johnst., are very common. I have obtained in considerable abundance with the dredge, in St. Aubin's Bay, *Ophiura albida*, Forbes, in association with a few specimens of *O. texturata*, Lam.

Asteriscus verruculatus, Retz., is very common everywhere; *Asterias glacialis*, Müll., is much less common on the shore; but with the dredge one may collect some interesting species in St. Aubin's Bay—*Palmipes membranaceus*, Retz., *Solaster papposus*, Retz., *Asterias rubens*, Linn. I may also cite *Cribrella occulata*, Penn., of which I found several specimens at La Mothe.

The Comatulæ are very rare on the coast, but not altogether wanting; they may be found at the Dog-Nest and at different parts of the Grève d'Azette.

Synaptæ (*S. inhærens*, Düb. & Kor.) are common in the vicinity of Elizabeth Castle. Of the Holothurians I have not met with a single species during my two visits. Mr. Sinel once captured at La Rocque a specimen of *Cucumaria* which has not been determined.

Vermes.

I shall consider first the Turbellaria and then the Polychæta.

Turbellaria.

Of the Planariæ the commonest species is *Leptopleura tremellaris*, Œrst., which is found adhering to the lower surface of stones, especially on the Grève d'Azette. A very elegant species which is sometimes associated with it, and which is also observed among the *Zosteræ*, is *Prostheceræus vittatus*, Lang. *Polycelis lævigatus*, Quatref., is often met with among the

seaweeds. I may cite, further, two species which appear to me to be much more rare, namely *Oligocladus sanguinolentus*, Lang., remarkable for the vivid coloration of the digestive tube, which is strongly coloured red; this I have met with only once at the Grève d'Azette (at the Pic-Triple rock); and *Stylochoplana maculata*, Stimps., of which I have found several specimens behind La Mothe.

Among the Nemerteans I shall mention, first of all, *Lineus longissimus*, Sim., which appears to be very common throughout the south-eastern region of the island, and *Lineus gesserensis*, Johnst., a small species of a dark green or nearly black colour. *Valencia splendida*, *V. longirostris*, and *V. ornata*, discovered by Quatrefages at Bréhat and at Chausey, are abundant at La Rocque in muddy sand covered with *Zosteræ*, where they live with *Marphysæ*, *Clymenæ*, and fossorial crustaceans.

Of the other species which I have met with at Jersey, and which I have been able to determine with certainty, I may mention:—*Tetrastemma candidum*, Müll., a very abundant species; *Amphiporus lactifloreus*, M'Int., common under stones among seaweeds; and *Polia filum*, Quatref., which no doubt does not differ from *Polia sanguiruba*, Quatref., for I have observed passage-types between these two forms, which, moreover, come very near to each other.

From the Grève d'Azette I have also obtained several examples of *Nemertes gracilis*, Johnst., and lastly some specimens of a bright rose-coloured *Nemertes*, 4 or 5 centim. in length, which I refer, with some doubt, to *Cerebratulus bilineatus*, Ren.

I should also have to record a great number of Rhabdocœlans which live among the seaweeds, associated with Nematodes and small Polychæta; but I have neither the time nor the books necessary for the study of these interesting types, which I am unwillingly compelled to pass over.

Polychœta.

Of the Aphroditina I shall first cite *Aphrodite hystrix*, Aud. & Edw., of which I have dredged several specimens in St. Aubin's Bay. Mr. Sinel showed me some fine specimens of *A. aculeata*, Linn., which he found in the same locality; but for my own part I never met with that species. As to the genus *Polynoë*, it is represented by *P. cirrata*, Müll., a very common species, and by *P. squamata*, Linn., and *Lagisca propinqua*, Malmgr., which are less frequent. To the same family belongs *Sthenelais Edwardsii*, Quatref.

To the Euniceans belong: *Eunice Harassii* and *E. Bellii*,

Aud. & Edw., common species under stones, especially the first-named; and *Marphysa sanguinea*, Aud. & Edw., which is very common in the muddy sands of La Rocque, and also under stones among the rocks of the Dog-Nest and at the Grève d'Azette. It is to be remarked that the specimens coming from the muddy sands break up with the greatest facility either spontaneously or when they are immersed in alcohol, while the specimens from rocky places scarcely ever break up. We may note further *Lysidice ninetta*, Aud. & Edw., and *Lumbriconereis contorta* and *L. humilis*, Quatref.

Among the Nereidians I will mention, first of all, three Nephthydians, namely, *Nephthys Hombergii*, Aud. & Edw., *N. scolopendroides*, Delle Chi., and *N. longisetosa*, Œrst. The first species, as is well known, is common on all sandy shores, in company with the *Arenicolæ*. The other two species are rare. The Nereids are represented by numerous specimens of *Nereis cultrifera*, Grube, and *N. Dumerilii*, Aud. & Edw., and a few of *Nereis* (*Praxithea*) *irrorata*, Malmgr. Behind La Mothe I have also captured a specimen of *Nereis Marionii*, Aud. & Edw. *Aonia foliacea*, Aud. & Edw., and *Nereilepas lobulatus*, Quatref., may also be mentioned.

In pelagic fishings I have also collected numerous specimens of an Annelide discovered at Dinard by M. de Saint-Joseph, namely, *Leptonereis Vaillanti*, St.-Jos.

The family Syllidia is represented by *Syllis amica*, Quatref., and *S. divaricata*, Kef., *Grubea fusifera*, Quatref., *Claparedia filigera*, Quatref., and other small species which live among the Fuci and Corallines.

Among the Phyllodocians I may mention *Eulalia clavigera*, Aud. & Edw., a common species, with which is sometimes associated *Eteone longa*, Sav. On the Grève d'Azette I have also captured some fine specimens of *Phyllodoce laminosa*, Sav.

The Glycerians are represented by *Glycera capitata*, Œrst., and *G. lepidum*, Quatref., both of which are rather rare.

I will cite further *Aricia Cuvieri*, Aud. & Edw., very common in the muddy sand at La Rocque; *Cirratulus Lamarckii*, Aud. & Edw., very frequent; *Siphonostomum uncinatum*, Quatref., also a very abundant species; *Ophelia bicornis*, Sav., which I did not myself find, but of which four specimens were brought to me one day by a fisherman, who told me that he had collected them at La Rocque, without giving me any further particulars; and, finally, *Leucodore ciliata*, Johnst., a species which does not appear to be very common.

Among the Sedentary Annelides it is hardly necessary to

mention *Arenicola piscatorum*, Cuv., which abounds in the sands of the shores, often accompanied by *A. ecaudata*, Johnst.; *Clymene lumbricoides*, Edw., is frequent in the mud of La Rocque, where *Petaloproctus terricola*, Quatref., also lives.

Chœtopterus Quatrefagesii, Jourd., is sometimes found under stones; its tube is attached to the under surface of pebbles, and is not bent into a U.

The *Terebellœ* are represented by *Terebella nebulosa*, Mont., which is met with under stones, especially in places where the water runs a little, and by *T. conchilega*, Pall., and *T. prudens*, Cuv.; these last two species, which live in tubes constructed of sand and shell-fragments, are everywhere abundantly distributed.

Among the Sabellians I will cite *Sabella pavonina*, Sav., common in the meadows of *Zostera*; *S. verticillata*, Quatref., which is pretty frequently met with in the midst of tufts of *Cynthia*; and, finally, *S. arenilega*, Quatref. *Protula protensa*, Grube, is found occasionally in the anfractuosities of rocks.

I will also mention *Vermilia conigera* and *V. tricuspis*, Quatref., *Serpula fascicularis*, Lam., *Spirorbis communis*, Flem., generally-distributed species, and, lastly, *Salmacina Dysteri*, Quatref.; in this last species, as is well known, the tubes which protect the individuals become united into voluminous ramified masses, thus forming a sort of polypary, as is also the case in an allied Mediterranean species, *S. œdificatrix*. The specimen of *Salmacina* that I possess was given to me by a fisherman, and came from the open sea.

Among the other groups of Vermes I must cite two Gephyrians (*Phascolosoma margaritaceum*, Sars, and *P. elongatum*, Kef.) as pretty common in muddy places.

A few words ought, perhaps, to be said of the Bryozoa; but as I have few remarks to make as to the habitat and stations of the different species, I shall content myself with giving hereafter the list of the species that I have met with.

As regards the Brachiopoda, I will only remark that M. Duprey found on the coast a small species of *Argiope* (*A. capsula*, Jeffr.), under pebbles buried in the beach to a depth of 8 or 10 inches, associated with *Chiton scabriculus*, *Adeorbis subcarinatus*, &c.

Ascidia.

Throughout nearly the whole extent of the Banc de Violet we find attached beneath the stones numerous specimens of *Ciona intestinalis*, Linn., a species abundantly distributed upon all our coasts. Side by side with the type-form, I have met with the two varieties *canina* and *fascicularis*. Associated with these forms we often find *Ascidia mentula*, Müll.; *Ascidiella aspersa* and *A. scabra*, Müll., are also met with on the Grève, but more rarely.

An exceedingly abundant form is *Cynthia rustica*, Müll., which covers the lower surface of certain rocks in company with *Halichondria panicea*. *Ascidia producta*, Hanc., also occurs sometimes adhering to the rocks. The genus *Cynthia* is further represented in Jersey by *C. granulata*, Ald., which is pretty common on the coast, and *C. sulcatula*, Ald., which I have dredged in St. Aubin's Bay.

Another species of Simple Ascidian which I have found in very great abundance at certain stations is the Molgulan rendered famous by the fine memoirs of M. de Lacaze-Duthiers, who has named it *Anurella roscovita*. I have found it in the same stations as those indicated by the learned Professor of the Sorbonne, that is to say, upon the beaches covered with fine sand, never completely uncovered at low water, at Elizabeth Castle and at La Rocque. *Anurella roscovita* is widely distributed upon these shores; its tunic is covered, as usual, with sand-grains and fragments of shell. The shell-fragments covering my specimens from Elizabeth Castle have been determined by M. Duprey, and belong to the following species:—*Rissoa labiosa*, *R. striata*, *R. parva*; *Cerithium reticulatum*; *Trochus striatus*, *T. cinerarius*, *T. umbilicatus*; *Littorina obtusata*; *Dentalium tarentinum*; *Astarte triangularis*; *Phasianella pulla*; *Purpura lapillus*; *Nassa reticulata*.

I also collected several specimens of a small *Molgula* attached to certain Algæ adherent to the rocks, which I refer to *Molgula socialis*, Ald. (young form), and some examples of *Ctenicella Lanceplaini*, Lac. *Polycarpa glomerata*, Ald., is pretty frequent upon the stems of *Laminariæ*, but appears always to have been thrown up by the sea.

The Social Ascidia are represented by numerous specimens of *Clavelina lepadiformis*, Wiegm., attached to the lower surfaces of rocks, and some of *Perophora Listeri*, Müll., very common on seaweeds.

The Compound Ascidia are exceedingly abundant; they are, however, of forms common on the French shores of the

Channel; and, in this respect, the fauna of Jersey presents a great analogy with that of Roscoff, investigated by Giard. I will cite, in the first place, *Aplidium zostericola*, Giard, very common on the *Zosteræ*; and the *Amaroucia*, some species of which (*A. Nordmanni*, *A. proliferum*, and *A. albicans*, Edw.) are very abundant. The *Amaroucia* are frequently associated with *Fragarium elegans* and *Morchellium argus*, described by Giard.

Didemnum is represented by a very common species forming small corms of variable colour, generally tending to bright yellow or grey, which may be referred to *D. sargassicola*, Giard. The genus *Leptoclinum* is very generally distributed; it includes, in the first place, *L. maculosum*, Edw., forming very extensive violet-coloured corms which are found at the base of the stems of *Laminariæ*. Associated with this, and exceedingly common, is *L. asperum*, Edw.; *L. durum*, Edw., and *L. fulgidum*, Edw., form greatly developed sheets, which cover the rocks; *L. gelatinosum*, Edw., lives in similar situations.

A new *Diplosoma* is abundant at Jersey; I have found it especially upon the *Laminariæ*. M. Lahille, who had also observed it at Roscoff, has described it under the name of *D. Kœhleri*.

The Botryllidæ are represented by *Botrylloides rotifera* and *B. rubrum*, Edw., and by numerous *Botrylli*. Besides some types, which by their coloration cannot be referred to any species described by Giard, I have met with: *B. Schlosseri*, Sav., generally the variety *adonis*, Giard, *B. pruinosus*, Giard, *B. smaragdus*, Edw., *B. violaceus*, Edw. (numerous varieties), *B. aurolineatus*, Giard, *B. morio*, Giard, and *B. rubigo*, Giard; the last two species are not so frequent as the others.

[To be continued.]

MISCELLANEOUS.

Freshwater Sponges from Newfoundland: a new Species. By Edward Potts.

The author stated that in the latter part of August 1885, Mr. A. H. MacKay, of Pictou, Nova Scotia, whose success as a collector of freshwater sponges in his own neighbourhood has been already recorded (Proc. Acad. Nat. Sci. Philad. 1884, p. 215, &c.), made a scientific visit to the island of Newfoundland. His explorations

were mainly limited to the irregular peninsular of Avalon, the south-easterly extremity of the island, and the record of his collections beside mentioning the neighbourhood of the city of St. Johns, embraces such familiar names as Trinity Bay, Harbour Grace, and Heart's Content, the landing-place of the Atlantic cable.

He writes, "I was extremely sorry that, owing to my limited time and the impenetrability of the interior to any ordinary effort, I could not gain access to the great lakes in the heart and the western portion of the island. I have merely made a dip into a few of the ponds on the N. (?) E. coast." These are more particularly mentioned as Virginia and Ouidi Vidi Lakes, near St. Johns; Lady Lake, Bannerman Lake, Rocky Lake, and Carbonear Lake, small bodies of water near Harbour Grace; and other lakelets and brooks upon the rocky ridges and near the sea-level between Harbour Grace and Heart's Content. All this region is described as "the Canadian Huronian, the equivalent of the English Cambrian;" and the collections were generally limited to the shallow margins of the ponds, where the sponges were found upon the undersides of splinters of hard slaty quartzites, in numbers very plentiful, but generally small—"from mere points to an inch or more in diameter."

It is to be regretted that the date of Mr. MacKay's visit was necessarily so early in the year, as the specimens collected were either immature or contained only the degenerate statoblasts of the preceding season. The information gathered as to the range of temperature upon this island is valuable as indicating so far the conditions of the growth of these and other organisms.

He says: "The island is not extreme in its temperature, and the frost does not go very deep into the soil. The lakes freeze in November or December with ice at least a foot in thickness, and remain closed until the end of April. The average temperature during eight years, from 1857 to 1864, was 41°·2 Fahr. Average maximum thermometer during the same time 83°, minimum 7°. In the year 1879, the mean temperature was 40°·2 Fahr.; highest record August 3, 82°, lowest December 22, +4°. In Nova Scotia, though that is so much further south, the range is far greater, from +96° to −20° or −24° Fahr., with an annual average of 44°."

The specimens of sponges so kindly forwarded by Mr. MacKay for examination and report were more or less minute incrustations upon small stones, gathered as above indicated, and belonging to the species *Spongilla lacustris*, auct.; *S. fragilis*, Leidy; *S. Mackayi*, Carter; *Meyenia fluviatilis*, auct.; and *Heteromeyenia pictovensis* and *Tubella pennsylvanica*, Potts. Of these *Spongilla fragilis* was by far the most abundant, and our knowledge of its range is thus extended along the eastern coast of North America from Florida to Newfoundland; whereas it had previously been traced westwardly to British Columbia near the Pacific Ocean, and more recently has been discovered in Russia, Bohemia, and England. Beside the familiar species, *S. lacustris*, *S. fragilis*, and *M. fluviatilis*, *Tubella pennsylvanica* has been rapidly enlarging its borders beyond the narrow limits of its original territorial designa-

tion; while *S. Mackayi* and *H. pictovensis* had previously been known only from the discoveries of Mr. MacKay in Nova Scotia.

One other form remains to be described, and at the suggestion of its discoverer it is hereby designated

Spongilla novæ terræ, n. sp.

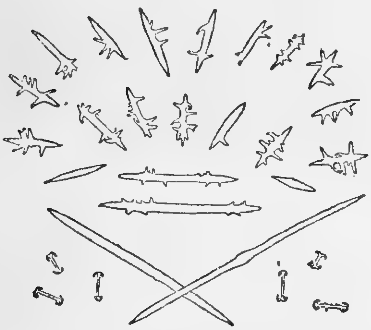
Sponge incrusting; sarcode of the young growth a dense mass of minute spherical cells, imbedding slender curving lines of fasciculated skeleton-spicules, developing later into a very loose, open tissue, with few connecting spicules.

Gemmules rather numerous, unusually large, spherical; chitinous coat thin; "crust" apparently wanting.

Skeleton-spicules relatively few, slender, cylindrical, smooth or sparsely microspined; gradually pointed.

Dermal or flesh-spicules very abundant, minute *birotulates* of unequal size; shafts slender, cylindrical, occasionally spined; outer surface of rotules dome-shaped; rays prolonged, terminations acute; malformations frequent. Mixed with occasional linear, spined spicules.

Spicules upon the gemmulæ abundant, crossing each other upon the crustless, chitinous body. Their shape when smooth is robust-fusiform, with pointed terminations; the great majority, however, have from one to six or more long spines non-symmetrically placed, but with an evident tendency to group themselves at points about one fourth the length of the spicule from one or both of its extremities.



Measurements: Diameter of gemmules 0·036 inch, skeleton-spicules 0·0068 by 0·0002 inch; length of average dermal spicule 0·00066 inch, of gemmula spicule 0·00145 inch.

Habitat. Incrusting stones in shallow water.

Locality. Lakes or ponds in the vicinity of Heart's Content, Newfoundland, collected by Mr. A. H. MacKay.

All the specimens of this sponge came from the neighbourhood of Heart's Content, but whether they were gathered from a lake upon the heights or from a brook mentioned by Mr. MacKay near the sea-level does not seem entirely clear. The accompanying illustration (magnified 225 diameters) will suggest the peculiarities of its skeleton, dermal and gemmular spiculation. The striking resemblance of the dermal spicules to the minute birotulates, heretofore only known in a corresponding position in the case of *Meyenia Everetti*, will at once impress the student. These are, however,

more variable in size, are occasionally spined, and have their rays more prolonged and more delicately terminated.

It is in the singular character of the spicules surrounding the gemmulæ that this sponge must attract peculiar attention. By the system of H. J. Carter, Esq., the freshwater sponges are now classified into six genera, besides some conditional designations of forms in which the typical features are as yet undiscovered. These six, *Spongilla*, *Meyenia*, *Heteromeyenia*, *Tubella*, *Parmula*, and *Carterius*, may again be associated into two groups, one of them including only the genus *Spongilla*, characterized by the *linear acerate* spicules surrounding the gemmulæ; and the other comprising all the other genera, where the spicule of corresponding significance is a *birotulate* or some easily recognized derivative of that type. Within this latter and larger group intermediate forms, connecting the defined genera, are frequent, and the location of species upon one side or other of the distinctive line comparatively unimportant. Heretofore, between the genus *Spongilla* and those genera composing the other group there has been "a great gulf fixed." One case only in the past has suggested their possible association, or the development of one group from the other.

In *Meyenia acuminata*, Potts (Proc. Acad. Nat. Sci. Philad. 1882, p. 69), since regarded as a variety of *M. fluviatilis*, the shafts of the birotulates are prolonged at each extremity, forming acuminate terminations some distance beyond the surface of the rotules. In position also these spicules are abnormal, lying flat upon the chitinous coat, instead of resting upon one rotule, their shafts taking the position of radii, as is usual in this form. In fact, we have the spicules of a *Meyenia* occupying the ordinary positions, and in degree approximating the forms of those peculiar to the Spongillæ.

In the present instance their intermediate character is still more striking, and while their form and position probably more closely associate them with the genus *Spongilla* in which the species has now been placed, the grouping of the ray-like spicules clearly suggests *Meyenia*. It has been an altogether unprecedented experience with the author to hesitate between these two genera, and it will be no cause of surprise if the future teacher shall shift it from its present position.

It must not escape notice that in both of these instances the gemmulæ are without "crust;" that it is difficult to understand how birotulates could be supported in their ordinary positions *without* these imbedding granules; and that we may not unreasonably infer that the change in position has induced the modification of type that we here find.

This collection of sponges, including the new species, has been examined coincidently by H. J. Carter, Esq., F.R.S., and their identification and this description are believed to meet his approval. —*Proc. Acad. Nat. Sci. Philad*, April 6, 1886, p. 227.

On the Biological and Morphological Value of the Bulbilli of Fungi. By M. Hugo Zukal.

The peculiar reproductive organs called "bulbilli" described by Eidam (Cohn's Beitr. zur Biol. iii.) have been found by the author in five fungi, namely *Helicosporangium coprophilum*, sp. n., *Dendryphium bulbiferum*, sp. n., *Haplotrichum roseum*, Link, *Melanospora fimicola*, Haus., and a *Peziza*. He ascertained that, as stated by Eidam, only conidial forms are, as a rule, developed from the bulbilli.

But in two instances, namely in *Melanospora* and *Peziza*, the bulbilli become converted into fruits, and hence he came to the conclusion that the bulbilli are to be regarded *morphologically* as undeveloped fruits, and therefore as aborted structures. In many fruits of Ascomycetes the bulbillus-form may occur as a perfectly normal stage of development. The so-called *sclerotia* of *Penicillium glaucum* may also be only modified bulbilli. The small bulbilli, in which little reserve-material is stored up, generally develop no fruits, but only mycelia.

The author remarks that his investigations on the whole confirm Eidam's statements, especially the fact that vegetative bodies occur in Fungi which behave biologically like the brood-bodies of the higher plants, but at the same time differ considerably in their structure from the sclerotia. But his observations, especially upon the species of *Peziza*, lead him to dissent from Eidam's further assertion—that fruits never proceed from these bulbilli.

As regards the theoretical estimation of the bulbilli, also, his views differ essentially from Eidam's. Eidam regards the bulbilli as perfectly normal structures, "spore-coils," which belong, as a definite reproductive form, to the developmental cycle of the Fungus in which they occur. The author's investigations lead him, on the contrary, to the opinion that the so-called bulbilli are not to be considered normal structures, but more or less undeveloped fruits, which have become heterogenously developed in consequence of disturbing causes (mites, parasitic fungi, cold, heat, drought). Karsten's statement ('Bot. Untersuch. aus dem phys. Laboratorium in Berlin,' Heft i. 1865, cited by Eidam) to the effect that it occasionally happens that a central cell of the bulbillus of *Helicosporangium parasiticum* becomes converted into an ascus containing eight elliptical spores, is therefore regarded by the author as perfectly correct. Karsten even saw an aborted perithecium which contained eight rudimentary spores. Consequently, the author says, such forms as *Papulaspora aspergilliformis* and *Helicosporangium parasiticum* can only be regarded as independent Fungi until the developed fruit-forms belonging to them shall be discovered, and the same statement applies to the forms here described by him as new.—*Verh. zool.-bot. Gesellsch. in Wien*, Bd. xxxvi. pp. 123–136.

Note on the Arterial System of the Scorpions. By M. F. Houssay.

The arterial system of the Scorpions is formed by two groups of vessels, one dorsal, the other ventral, united on the one hand by two short vessels at the anterior part and on the other by an unpaired duct situated in the median part of the animal's body.

Dorsal group.—From the heart, which is entirely seated in the preabdomen, two aortas start anteriorly and posteriorly. The anterior aorta passes without ramification to the cerebroid ganglia, where it suddenly terminates. From the termination issue four arteries—two which pass to the dorsal eyes of the cephalothorax, and two others which run to the chelicera, furnishing in their course a branch for the lateral eyes and another which is distributed to the muscles. The posterior aorta traverses the post-abdomen, and ramifies in a very homogeneous manner in all the segments. At the anterior part of each segment it gives off two very short arterioles, and in the middle of the segment two stouter arteries which bifurcate into two branches perpendicular to their direction.

Ventral group.—This is the most interesting from the relation which it presents to the nervous system. It consists of a lacuna which surrounds the oval ganglionic mass of the cephalothorax and of a vessel enclosed in the sheath of the abdominal nervous chain. The blood occupies the space enclosed between the two nerve-filaments, which run from one ganglion to another, and spreads around each ganglion in such a way as to form at this point a small lacuna.

From the cephalothoracic perinervous lacuna issue on each side five trunks, which run to the legs. The blood and the nerve of each leg are at starting in the same envelope.

All the ramifications starting from the abdominal canal issue at the level of the ganglion, and there also a nerve and a blood-current quit the common envelope together.

Communicating arteries.—These two groups are united at the anterior part by two vessels, which embrace the digestive tube. These two vessels envelop the commissures which run from the cerebroid ganglia to the ventral mass. They place the perinervous lacuna in communication with the termination of the anterior aorta. The blood is not diffused around the brain, whether it be that these ganglia have a special envelope, just permitting the issue of the commissural nerve-filament in order that it may penetrate into the blood-vessels, or that the common envelope is so closely applied to the nervous mass that the blood cannot penetrate between them.

The other communication between the two groups is established by a vessel which starts from the posterior aorta at the middle of the seventh segment of the preabdomen. It buries itself between the two small lobes by which the liver is produced into the post-abdomen; then it passes to the right of the digestive tube and opens into the perinervous lacuna at the level of the ganglion of the first segment of the postabdomen.

This relative arrangement of the circulatory and nervous systems, already indicated in *Limulus* and the Myriopoda, is thus found to extend also to a group of Arachnida.—*Comptes Rendus*, August 2, 1886, p. 354.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 106. OCTOBER 1886.

XXVI.—*Notes on the Palæozoic Bivalved Entomostraca.—No. XXII. On some undescribed Species of British Carboniferous Ostracoda* *. By Prof. T. RUPERT JONES F.R.S., and JAMES W. KIRKBY, Esq.

[Plates VI., VII., VIII., & IX.†]

In this paper it is proposed to notice the undescribed species of Carboniferous Ostracoda occurring in Britain. This has been suggested to us as necessary for the better understanding of our papers on the distribution of these fossils, now about to be published by the Geological Society and the Geologists' Association.

The descriptions of these species are brief, and the figures in illustration of them are limited, in most cases, to two or three views of each. It is believed, however, that they will suffice for the identification of the species; and they will certainly help our observations on their distribution.

In noticing the following species, in many instances we give only a few of their localities; and this is invariably the case where the species are of common occurrence, as exhaustive

* For No. XXI. see Ann. & Mag. Nat. Hist. for May 1886, p. 403.

† These Plates have been drawn with the aid of a grant from the Royal Society for the illustration of Fossil Ostracoda.

lists would take up too much space in the present brief account.

1. *Bythocypris Phillipsiana*, Jones & Holl, var. *carbonica*, nov. (Pl. VI. figs. 1 *a*, 1 *b*, 2 *a*, 2 *b*.)

Bairdia Phillipsiana, J. & H., Ann. & Mag. Nat. Hist. ser. 4, vol. iii. p. 213, pl. xiv. fig. 7.

Subovate or bean-shaped, convex; dorsal border arched, ventral border straight, extremities rounded, the anterior being smallest; the left valve overlaps the right all round; lateral contour ovate, widest behind, pointed in front; surface smooth or minutely punctate. Length $\frac{1}{40}$ to $\frac{1}{35}$ inch.

This little Ostracod has much the form of the common Coal-measure Cyprid (?) *Carbonia fabulina*, J. & K., with which it has sometimes been confounded. It is, however, smaller than the latter, has the left valve (instead of the right) the largest, with a more decided overlap, and it is always found in the marine beds of the Carboniferous-Limestone series with Corals, Crinoids, Brachiopods, &c., and never in estuarine beds with plants and fish-remains as the *Carbonia* occurs. Discovered by Mr. John Young, F.G.S., of Glasgow.

B. Phillipsiana (formerly *Bairdia*) is a Silurian species differing but little from this form, which we place with it as a variety. *Bythocypris bilobata* (Münster) (*Cythere*, Ann. & Mag. Nat. Hist. ser. 3, vol. xv. p. 409, pl. xx. fig. 10) is a Carboniferous relative, also of similar form, though nearly twice the size.

Localities. Arnside, in Westmoreland; Woodend Quarry and Dun Quarry, near Lowick, Northumberland; Barmullock Old Quarry, Hillhead Quarry, near Wilsontown, County Boundary, Lanarkshire.

2. *Bythocypris* (?) *cuneola*, Jones & Kirkby. (Pl. VI. figs. 3 *a*, 3 *b*, 3 *c*, 4 *a*, 4 *b*, 5, 6, 7 *a*, 7 *b*.)

Cythere * *cuneola*, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 223.

Elongate or suboblong, convex, with greatest height and width rather behind the centre; dorsal border flatly convex, ventral border straight, extremities rounded; left valve

* The difficulty of allocating fossil Ostracodous valves to their true genera has been often noticed. *Cythere* was formerly the recipient of nearly all doubtful forms, and is still conveniently used. Judging, however, by the relative size of the right and left valves (where possible), in combination with their shape, we can refer to some recent genera as representing certain old and even Palæozoic Ostracods, with more or less certainty.

largest and overlapping the right; a short spine is occasionally present on the postero-ventral region, and sometimes a dark round spot in the centre of the valve; lateral contour elongate-ovate or subcuneiform. Shell thick; surface smooth. Length $\frac{1}{30}$ inch.

Usually referred to this species is a form (fig. 7) similar in size and general character, but with the dorsal border arched and the posterior extremity obtusely pointed. This we consider a variety.

B. cuneola is common in the marine shales of the Carboniferous-Limestone series in Scotland, and in similar deposits of the Yoredale rocks in England. Discovered by Mr. John Young, F.G.S.

We are not quite sure about fig. 7; but we have always regarded it as belonging to *B. cuneola*, and have found it at several places.

Localities. Holker Park, Scales Green, Humphrey Head, in Lancashire; Arnside, Sandside, Heversham, in Westmoreland; Dun Quarry and Woodend Quarry, near Lowick, Ancroft, Scremerston, Elsdon Burn, Penchford, in Northumberland; Brockley, Mousewater, and Haywood, near Wilsontown, Brankumhall Quarry, Boghead, Robroystone, Meikle Earnock Burn, Kennox Water, in Lanarkshire; Darcy Quarry, Brunston Colliery, in Midlothian; Whitebaulks, Kinneil Mill, in Linlithgowshire; Seafield Tower, Gleniston Quarry, Wilkieson Quarry, Ravenscraig, in Fife; and in many other places.

B. cuneola also occurs in the Calciferous Sandstone at Linnhouse Water, opposite Oakbank Oil-works, Linlithgow; River Esk above Gilnockie Tower, Dumfriesshire; Back Burn, Plashetts, Northumberland.

3. *Bythocypris* (?) *cornigera*, J. & K. (Pl. VI. figs, 8 *a*, 8 *b*, 8 *c*, 9.)

Cythere cornigera, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 223.

Suboblong, very convex, and quadrately horned behind; left valve largest and overlapping; surface smooth; lateral contour subcuneiform. Length $\frac{1}{35}$ to $\frac{1}{27}$ inch. Old specimens have the valves very tumid and the extremities truncate. This species is evidently a near relation to *B. cuneola*, with which it is often associated. Discovered by Mr. John Young, F.G.S.

Localities. Scales Green, Humphrey Head, in Lancashire; Ancroft, Penchford, Dun Quarry, near Lowick, in Northumberland; Brockley, Ponfeigh Burn, Mousewater, Calderside Quarry, Kennox Water, in Lanarkshire; Whitebaulks, Lin-

lithgowshire; Carlops Quarry, Whitefield Old Quarry, in Peebleshire; Sunnybank Quarry, Abden, Gleniston Quarry, Charlestown, Wilkieson, in Fife.

4. *Bythocypris* (?) *pyrula*, sp. nov. (Pl. VI. figs. 10 *a*, 10 *b*, 10 *c*, 11.)

B. (?) *pyrula* is a rare form, though apparently of more recent occurrence in the southern than in the northern portion of the British area.

It is subtriangular or sublunate in outline, highest behind; the dorsal border is arched, the ventral incurved, with a rounded or subangular posterior extremity, and an obtusely pointed anterior. The valves are convex and smooth; the lateral contour is acute-ovate with the greatest width near the centre. Length $\frac{1}{35}$ inch. Discovered by the late Mr. Charles Moore, F.G.S.

Localities. In Carboniferous Limestone at Backwell, Holwell*, and Weston-super-Mare, Somerset; Arnside, Westmoreland.

5. *Bythocypris* (?) *Moorei*, sp. nov. (Pl. VI. figs. 12 *a*, 12 *b*, 12 *c*.)

It is questionable if we have seen this species in a thoroughly perfect condition. The only specimens examined by us are from the Carboniferous Limestone of Weston-super-Mare, and sent to us by the late Mr. C. Moore.

It is comparatively large, being $\frac{1}{20}$ inch or more in length; has a long, flatly-convex, dorsal border; a shorter ventral border; one extremity much higher than the other and boldly curved ventrally; and the small extremity evenly rounded. The valves are rather compressed, and their contour, as seen from above, is almost lanceolate, widest at anterior (?) third.

6. *Bythocypris* (?) *thraso*, J. & K. (Pl. VI. figs. 13 *a*, 13 *b*.)

Cythere thraso, Jones, MS. 1867, Quart. Journ. Geol. Soc. vol. xxiii. p. 494.

Suborbicular, rather longer than high; dorsal and extreme borders rounded, ventral flattened; valves very convex, one larger than the other and slightly overlapping it; lateral contour oval; surface smooth. Length $\frac{1}{35}$ inch. Discovered by the late Mr. C. Moore.

A rare species, and only as yet found in the Carboniferous

* Quart. Journ. Geol. Soc. vol. xxiii. p. 483.

Limestone of Charterhouse *, Somersetshire, and Woodend Quarry, near Lowick, Northumberland.

7. *Bythocypris lunata*, sp. nov.
(Pl. VI. figs. 15 *a*, 15 *b*.)

Lunate, highest in the centre; dorsal border arched, ventral border straight, except where it curves up to the extremities, which are subacute, and one slightly the larger; lateral contour lentiform, widest in the centre; surface smooth (?). Length $\frac{1}{20}$ inch.

It is only known to us from the Carboniferous Limestone of Holwell, Somerset, where it was found by Mr. C. Moore.

Bythocypris sublunata, J. & K. (Geol. Mag. 1886, p. 250, pl. vii. figs. 9–11), comes near the present species in general form, and is possibly nearly related to it; but it is smaller, relatively higher, and has more acute extremities.

8. *Cythere* (?) *gyripunctata*, J. & K.
(Pl. VI. figs. 14 *a*, 14 *b*.)

Cythere gyripunctata, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Ovate in outline, highest behind, very convex; dorsal border short and straight; ventral border convex, projecting posteriorly; extremities rounded, the anterior being smallest; lateral contour oval, with pointed extremities; surface coarsely striated and pitted concentrically; valves apparently of equal size. Length $\frac{1}{35}$ to $\frac{1}{30}$ inch.

This rare species has been found only in the Carboniferous Limestone of Arnside, Westmoreland.

9. *Leperditia Armstrongiana*, J. & K.
(Pl. VII. figs. 1 *a*, 1 *b*.)

Leperditia Armstrongiana, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 219.

L. Armstrongiana is a well-marked species and can always be identified by its large antero-dorsal spines, or the stumps usually left of them.

The valves are much higher behind than in front, with the posterior extremity boldly rounded and passing imperceptibly into the ventral margin, which is very convex; anterior extremity much the smaller, rounded or subangular; dorsal margin straight; lateral contour lentiform, widest a little in front of centre; surface smooth. Length $\frac{1}{18}$ inch.

* Quart. Journ. Geol. Soc. vol. xxiii. pp. 491–495.

The spines, which occupy the position of the "eye-spot" of other *Leperditiæ*, are stout at the base, of considerable length, and tapering to a fine point; they are directed outward, upward, and rather forward. In casts from Law Quarry, Ayrshire, kindly sent us by Mr. James Bennie, the spines are about one third of the valve-length.

This species was discovered by Mr. James Armstrong in the Carboniferous-Limestone series at Howrat Quarry, East Kilbride, Ayrshire; it is also found in the same series at Carluke and Brockley, in Lanarkshire, and Craigenglen, Stirlingshire, and in the Scar Limestone near Storr Moss, Lancashire.

10. *Leperditia Bosquetiana*, sp. nov.
(Plate VII. figs. 2 *a*, 2 *b*, 2 *c*.)

Suboval in outline; valves convex, flattened centrally; dorsal border short and straight; ventral border elliptical; extremities regularly rounded; lateral contour compressed-ovate, rather widest at posterior third, obtusely pointed behind, rounded in front. Length $\frac{1}{20}$ inch.

This species first became known to us when examining material from Belgium, given to us by our late friend M. J. Bosquet, of Maastricht. It was afterwards found by Mr. James Thomson in Carboniferous Limestone at Tirfergus Glen, Campbelltown, Argyleshire.

11. *Leperditia Youngiana*, J. & K.
(Pl. VII. figs. 3 *a*, 3 *b*, 3 *c*.)

Leperditia Youngiana, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 218.

Subovate, compressed; dorsal border rather short; ventral border elliptical, posterior extremity regularly rounded; anterior extremity more pointed than the other and with a well-marked dorsal angle; valves rimmed, widest near centre; surface finely punctate. Length $\frac{1}{20}$ inch.

This species, discovered by Mr. John Young, is mainly characterized by the punctate surface of its valves. It occurs abundantly in a bituminous shale of the Carboniferous-Limestone series at the Den pit, Dalry, and at a pit at Lugton, Dunlop, both in Ayrshire.

12. *Leperditia scotoburdigalensis* (Hibbert).
(Pl. VII. figs. 4 *a*, 4 *b*.)

Cypris scotoburdigalensis, Hibbert, 1834, Trans. Roy. Soc. Edinburgh, vol. xiii. p. 179.

Leperditia scotoburdigalensis, J. & K., 1866, Ann. & Mag. Nat. Hist. ser. 3, vol. xviii. p. 34; Jones, 1884, Proc. Berw. Nat. Club, vol. x. pp. 321 and 324, pl. ii. figs. 7 and 9.

Suborbicular, slightly oblique, convex; height three fourths of length; dorsal border short; ventral border and extremities continuous and boldly curved; lateral contour elliptical in males (?), ovate in females (?), greatest width rather in front of centre; valves rimmed, left moderately overlapped by right; muscle-spot circular, convex within, concave without; surface smooth. Length $\frac{1}{35}$ to $\frac{1}{25}$ inch.

In many localities where this species occurs there are both thin and fat specimens, as in the case of *Leperditia Okeni* and other species; the former we regard as probably males, the latter as females, similar differences of carapace being well known to mark the sexes in many cases among recent Ostracoda.

L. scotoburdigalensis was noted and illustrated by a poor woodcut in Hibbert's classical memoir on the Burdiehouse Limestone. It is not therefore an absolutely undescribed species; but, for the sake of easy reference, we include a notice of it in this paper.

It is about the most common and characteristic Ostracod of the Lower Carboniferous strata of Scotland. Some of the shales and limestones of that series are filled with its remains, and it is found on many horizons.

Localities. In Carboniferous-Limestone series: Hurlet Pits, Renfrewshire; Craig Burn (Douglas), Braidwood Burn (Carluke), Lanarkshire; Tweedmouth &c., Northumberland.

In Calciferous Sandstones: Billow Ness, Pittenweem, Caiplie, Randerstone, Pitmilly Burn, Buddo Ness, Craigkelly Quarry, Grange Quarry, in Fifeshire; Burdiehouse, Craiglockhart, Water of Leith, in Midlothian; Linnhouse Water, near Oakbank Oil-works, Linlithgowshire; Penton Bridge, Dumfriesshire; south of Cockburnspath, Burnmouth, in Berwickshire.

13. *Leperditia parallela*, J. & K.
(Pl. VII. figs. 5 *a*, 5 *b*.)

Leperditia parallela, J. & K., 1865, Ann. & Mag. Nat. Hist. ser. 3, vol. xv. p. 407, pl. xx. figs. 6 *a*, 6 *b*.

This species was figured and described from Bavarian specimens in 1865, as quoted above. We figure it anew from British examples and on a larger scale; but we can add nothing to the description then given. It is rare and has occurred to us only from the following localities:—

Carboniferous-Limestone series: Ladedda Quarry, Fifeshire; and railway-tunnel near Bristol.

14. *Leperditia obesa*, J. & K. (Pl. VII. figs. 6 *a*, 6 *b*.)

Leperditia obesa, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Suborbicular; valves evenly convex; ventral border boldly elliptical, posterior extremity flatly convex and rather higher than the anterior; surface irregularly bestrewed with comparatively large shallow pits, except near the free margins, where there is a narrow band without them; a roundish spot or area in the centre of the valve is also free from them; overlap moderate. Length $\frac{1}{30}$ to $\frac{1}{27}$ inch.

This species is somewhat like *L. suborbiculata* (Münster) and *L. scotoburdigalensis* (Hibbert) in outline, but differs from them in its pitted surface. It is rare in the Carboniferous Limestone at Arnside, Westmoreland.

15. *Leperditia compressa*, J. & K.
(Pl. VII. figs. 7 *a*, 7 *b*.)

Leperditia compressa, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 219.

Nearly oval in outline, highest behind (in some) or in the centre; valves flattened in the central two thirds, then sloping abruptly to the margins, which are rimmed; dorsal border short and straight, ventral border elliptical, extremities rounded, the anterior more pointed than the other; lateral contour compressed-oval; surface smooth. Length $\frac{1}{15}$ inch.

L. compressa was discovered by Mr. John Young at Craigenglen, Campsie, Stirlingshire; it also occurs in the Yoredale series, at Whorlton and Barnard Castle, in Durham; and in the Carboniferous Limestone near Bundoran, Co. Donegal, Ireland.

16. *Leperditia lovicensis*, sp. nov.
(Pl. VII. figs. 8 *a*, 8 *b*.)

Subtrigonal in outline; valves swollen in centre, compressed at extremities; anterior extremity subacute, posterior high and rounded; overlap of right valve slight; surface finely and densely punctate. Length $\frac{1}{30}$ inch.

Rare in shale above the Limestone (Yoredale), Woodend Quarry, Lowick. The material was sent to us by Mr. James Bennie.

17. *Leperditia acuta*, J. & K. (Pl. VII. fig. 9.)

Leperditia Okeni (Münster), var. *acuta*, J. & K., 1865, Ann. & Mag. Nat. Hist. ser. 3, vol. xv. p. 406, pl. xx. fig. 4.

Subtrigonal, oblique; anterior extremity acute and sloping

rapidly inward beneath; posterior extremity higher and sloping as rapidly outward until it sweeps round to the front to form a short, convex, ventral margin; right valve overlapping the other moderately; surface smooth. Length $\frac{1}{30}$ inch.

It is convenient to treat this as a species. It was figured, as above quoted, from a Bavarian example. We now give a figure of a specimen from the Scar Limestone of Arnside. It also occurs at Back Burn, Plashetts, Northumberland, Weston-super-Mare, Somerset, and other places.

18. *Beyrichia radiata*, J. & K. (Pl. VIII. figs. 1, 2 *a*, 2 *b*.)

Beyrichia radiata, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 220.

Subrhomboidal in outline, highest in front; dorsal border straight, ventral border convex; valves convex, with a round prominent boss rather behind the centre, and separated from a small anterior boss by a deep sulcus; a curious broad submarginal sickle-like plate, cross-lined, so as to represent a solid radiate frill, runs concentrically from the antero-dorsal angle to the postero-ventral curve; surface smooth, granulated, or tuberculated; shell thick. Length $\frac{1}{25}$ to $\frac{1}{22}$ inch.

This strongly-marked species (discovered by Mr. John Young) characterizes the Carboniferous-Limestone series and upper half of the Lower Carboniferous. In the former it is found at:—

East of St. Monans, Wilkieson Quarry, Sunnybank Quarry, Teasses Quarry, in Fifeshire; East Salton, Paiston Quarry, Burlage Quarry, in East Lothian; Hillhead Quarry (Wilsontown), Williamswood, Robroystone, Calderside Quarry, Boghead Quarry, in Lanarkshire; Craigenglen, Stirlingshire; Orchard Quarry, Renfrewshire.

In Calciferous Sandstone: Pittenweem, Fifeshire; Harelawhill, Roxburghshire; Cam Beck, Cumberland; Plashetts, Northumberland; Kendal and north of Storr Moss (in Scar Limestone), Westmoreland.

19. *Beyrichia longispina*, sp. nov. (Pl. VIII. fig. 3.)

Similar in general form to the species immediately preceding, and lobed or bossed in the same way; but with no submarginal plate. In lieu of the latter feature are two large, curved, ventral spines, which are tubular (?) and always placed in the same position—one towards each extremity. Length $\frac{1}{23}$ inch.

Localities. In the Carboniferous-Limestone series, at Murrayfield Pit, Linlithgowshire.

In Lower Carboniferous: Cam Beck, Cumberland; Plashetts, Northumberland.

20. *Beyrichia fodicata*, sp. nov. (Pl. VIII. figs. 4, 5, 6.)

Oblong; dorsal border straight, ventral border straight or slightly convex; extremities rounded; valves divided into three or four lobes by deep sulci, the posterior lobe sometimes curving round ventrally to near the anterior third; surface smooth. Length $\frac{1}{27}$ inch.

The only specimens we have seen of this species are single valves, collected by Mr. James Bennie from the Carboniferous-Limestone series (Upper) at Linlithgow Bridge.

21. *Beyrichia tuberculospinosa*, sp. nov. (Pl. VIII. figs. 7, 8.)

A small, subovate, rather compressed species, very curiously tuberculated and spiked. The two specimens figured have four or five round tubercles and a postero-dorsal spike on each valve. These features vary, however, in number in other specimens; some have two or three spikes on each valve, others have none, but only tubercles, and others again have more tubercles than here figured. Length $\frac{1}{45}$ inch.

Mr. John Young discovered this species in the Carboniferous-Limestone series at Boghead Quarries (Hamleton), Lanarkshire; it also occurs in the same series at Stacklawhall (Stewarton), Ayrshire; Craigenglen, Stirlingshire; Murrayfield, Linlithgowshire; Sunnybank Quarry, Fifeshire; Skellygate (Ridsdale), Northumberland.

22. *Beyrichia multiloba*, J. & K. (Pl. VIII. figs. 9 *a*, 9 *b*, 9 *c*.)

Beyrichia multiloba, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 219.

Another small *Beyrichia* with the surface of its valves broken up into three or four mammiform or clavate lobes (the centre one of which projects above the dorsal border) by deep and wide sulci. In general form it is almost subpentagonal, being straight above, subangular below, and nearly truncate at the extremities, the anterior of which is the smallest; the right valve is largest and overlaps the left; the surface is faintly reticulated (with large meshes). Seen from above (or below)

compressed-ovate, with very blunt extremities. Length $\frac{1}{45}$ inch.

Discovered by the late Dr. Rankine, of Carluke, as impressions in an alum-shale of the Carboniferous-Limestone series at Raes Gill, Carluke. It is found in the same series also at Boghead, Blantyre, Gair, Mousewater (Wilsontown), in Lanarkshire; Craigenglen, Stirlingshire.

23. *Beyrichia varicosa*, sp. nov. (Pl. VIII. figs. 10, 11.)

This species is somewhat akin in character to *B. fodicata*, but it is smaller, and has larger lobes, of which it possesses three, the anterior one being the largest. The valves appear to have been strongly rimmed. Length $\frac{1}{35}$ inch.

Collected by Mr. James Bennie at Whitebaulks, Linlithgowshire, where it is rare. A similar form is found at Gair, near Carluke, and also at Brunston Colliery, Midlothian. These localities are all in the Carboniferous-Limestone series.

24. *Beyrichia* (?) *bicæsa*, sp. nov. (Pl. VIII. figs. 12, 13.)

Suboblong; with rounded ends, the anterior being largest and most projecting; dorsal border straight and about two thirds of the total length; ventral border incurved at the centre, rounded towards the ends; valves compressed above, rather convex below, and with two straight and parallel cuts or narrow grooves that pass from near the antero-dorsal border diagonally backward halfway across the valve; surface smooth. Length $\frac{1}{30}$ inch.

The straight narrow sulci of this species are not typically Beyrichian, and we have only seen another Carboniferous form with anything like them. This form is from Weybourne, Cumberland (Carboniferous-Limestone series), and has a single narrow groove.

Sent to us by Mr. James Bennie from shale above Robroystone Limestone (Carboniferous-Limestone series) and labelled "Woodhill."

25. *Primitia* (?) *Holliana*, sp. nov.
(Pl. VIII. figs. 14 *a*, 14 *b*, 14 *c*.)

Small; sublunate in outline, with convex valves; dorsal border straight, ventral border arched; posterior extremity subacute. A deep V-shaped sulcus marks the centre of the valve; lateral contour subovate; surface smooth. Length $\frac{1}{35}$ inch.

Found by Dr. H. B. Holl, F.G.S., in Carboniferous Limestone, Great Ormes Head.

This and the two following unisulcate forms have the aspect of *Primitia*, but further research is necessary before we can determine if they belong to that genus or to our new group *Beyrichiella* (Geol. Mag., Oct. 1886).

26. *Beyrichiella* (?) *reticosa*, sp. nov.
(Pl. VIII. figs. 15, 16 *a*, 16 *b*, 16 *c*.)

Obliquely subovate; valves compressed in front, widest behind, and thus with a subcuneiform lateral contour. A deep and narrow sulcus marks the centre of each valve, and the postero-dorsal region of each is sharply ridged, leaving a depressed dorsal area between; right valve slightly larger than the left. Surface regularly reticulate. Length $\frac{1}{40}$ to $\frac{1}{35}$ inch.

The angulate postero-dorsal region of this species (not well shown in fig. 16 *b*) suggests relationship to *Beyrichiella*; further knowledge of it may probably cause its removal to that genus.

Collected by Mr. James Bennie in the Carboniferous-Limestone series at Whitebaulks, Linlithgowshire; and Abden, Fifeshire.

27. *Beyrichiella* (?) *ventricornis*, J. & K.
(Pl. VIII. figs. 17, 18 *a*, 18 *b*, 18 *c*.)

Cythere ventricornis, J. & K., MS. 1867, Trans. Geol. Soc. Glasgow, vol. ii. p. 223.

Obliquely subovate; convex, especially below; dorsal border straight; ventral border convex; anterior extremity high and rounded, protuberant below; posterior extremity smaller than the other and curving backward below. A simple shallow sulcus extends from the dorsal border less than halfway across each valve, near the centre; a short spine is always present on the postero-ventral region, and very rarely another is seen at the postero-dorsal angle. Lateral contour ovate, wide behind, narrow in front. Valves nearly equal; surface smooth. Length $\frac{1}{40}$ to $\frac{1}{35}$ inch.

We place this species in *Beyrichiella* on account of its Leperditioid outline, unisulcate valves, and probable dorsal crests. It belongs, however, to a very simple type of the genus.

Mr. John Young discovered this species, which is a characteristic form of the Carboniferous-Limestone series in Scotland, and of the Yoredale rocks in England.

Localities. St. Monans, Inverteil Quarry, Charlestown

Quarry, Roscobie Quarry, in Fifeshire; Kidlaw Quarry, Burlage Quarry, in East Lothian; Whitebaulks, Linlithgowshire; Barmullock Quarry, Williamswood, Brockley, Gair, Robroystone, in Lanarkshire; Orchard Quarry, Renfrewshire; Scales Green, Humphrey Head, in Lancashire.

28. *Kirkbya tricollina*, J. & K. (Pl. VIII. fig. 19.)

Kirkbya tricollina, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Dorsal border straight or slightly incurved; ventral border convex; extremities flatly rounded or subtruncate. Three round tubercles form the chief character, one placed just above the centre of valve, the others high up, one near each extremity. Free margin strongly rimmed; surface strongly reticulate; traces of a subcentral oval pit just below middle tubercle. Length $\frac{1}{30}$ inch.

Rare in the Scar Limestone at Arnside, Westmoreland.

29. *Moorea obesa*, sp. nov.
(Pl. VIII. figs. 20 *a*, 20 *b*.)

Subtriangular in outline, greatest length rather below the dorsal border; dorsal border incurved; ventral and extreme borders forming an inverted arch; extremities pointed; free margins rimmed, a little inside of which is another and stronger ridge, continuous and concentric; main area of valve smooth. Length $\frac{1}{30}$ inch.

A very rare species, and only known from the *débris* of Carboniferous Limestone in a vein at Brocastle, near Bridgend, Glamorganshire, where it was collected by Mr. Charles Moore, F.G.S.

30. *Moorea tenuis*, sp. nov. (Pl. VIII. figs. 21 *a*, 21 *b*.)

This species is from the *débris* of Carboniferous Limestone in a vein at the Charterhouse lead-mine, Mendip Hills, Somerset, and it has much the outline of *M. obesa*, but the dorsal border is convex instead of incurved, and the valves are less compressed. The inner ridge is also further away from the margin and almost regularly oval in shape, thus not concentric; the surface seems to have been smooth. Length $\frac{1}{30}$ inch.

These two species * and *Moorea silurica*, J. & H. (Ann. & Mag. Nat. Hist. ser. 4, vol. iii. p. 225, pl. xv. fig. 8), are the only members of the genus known to us, and that but

* These were referred to in the Quart. Journ. Geol. Soc. vol. xxiii. 1857, pp. 494, 523, and 559, as *Moorea obesa* and *M. tenuis*, Jones, MS. (once with a misprint of "*obtusa*" for *obesa*).

imperfectly. They are very curious Ostracods, apparently more nearly related to *Kirkbya* than to any other group.

31. *Cytherella* (?) *reticulosa*, J. & K.
(Pl. VIII. figs. 22 *a*, 22 *b*.)

Cytherella? reticulosa, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Oblong; dorsal and ventral borders straight and parallel; ends rounded, one a trifle more prominent than the other; valves moderately convex, and apparently not very unequal in size; surface regularly reticulated, mesh rather large; a round muscle-spot is seen in the centre of the valve, in casts. Length $\frac{1}{45}$ to $\frac{1}{40}$ inch.

This neat little form has the aspect of *Cytherella*, and we place it in that genus on that account, though with some doubt, as there is not the usual difference in the size of valves of *Cytherella*, and we have not seen any interiors.

It has occurred in the Carboniferous-Limestone series at Dun Quarry (Lowick), Northumberland; and in the Scar Limestone, north of Storr Moss, Westmoreland.

32. *Cytherella valida*, J. & K., var. *affiliata*.
(Pl. IX. figs. 1 *a*, 1 *b*.)

Subpentagonal in outline, compressed, umbilicated; dorsal border subangulate; ventral border straight; anterior extremity rounded and larger than the posterior, which latter is obliquely truncate; lateral contour much compressed, pointed in front, truncate behind; surface smooth. Length $\frac{1}{22}$ inch.

This form resembles *C. valida* in general outline, but differs from it in its compressed and posteriorly truncated lateral contour; also in its central pit or umbilicus. For the present we retain it under this species as a variety.

A similar, though probably distinct, form occurs in the Lower Carboniferous at Tweeden Burn and Pittenweem.

Locality. In Yoredale beds at Gleaston Castle (near Barrow-in-Furness), Lancashire.

33. *Cytherella* (?) *elongata*, sp. nov.
(Pl. IX. figs. 2, 3.)

Small, elongate, highest behind; dorsal border straight and long; ventral border straight or flatly convex; extremities rounded (with dorsal angles), the posterior being higher than the anterior; free margins rimmed, the right overlapping the left moderately; shell thin; surface smooth. Length $\frac{1}{40}$ inch.

Fig. 3 is a right valve, showing a flat marginal area, wider behind than before.

This species is doubtfully referred to *Cytherella*. It was collected by Mr. Bennie in the Carboniferous-Limestone series at Murrayfield (Bathgate), Linlithgowshire.

34. *Bythocythere antiqua*, sp. nov.
(Pl. IX. figs. 5 *a*, 5 *b*.)

Subrhomboidal in outline, tumid; dorsal border nearly straight; ventral border convex; anterior extremity subtruncate and projecting below; posterior extremity flatly rounded and projecting above. Valves apparently equal, and with a ventral expansion or wing, as in the recent *Bythocythere* and *Cytheropteron*, which is most developed posteriorly; lateral contour subovate with pointed ends, greatest width about the posterior third; surface pitted, pits shallow, rather large, and wide apart. Length $\frac{1}{30}$ inch.

We have two examples of this interesting species from Mr. G. R. Vine, of Sheffield, who obtained them from the Lower Carboniferous of Skellygate (Ridsdale), Northumberland.

35. *Bythocythere Youngiana*, sp. nov.
(Pl. IX. figs. 4 *a*, 4 *b*.)

This is a smaller species than that just noticed, and less angular in outline. The ventral wings also are relatively smaller; the lateral contour of regular width throughout (compressed-oval with pointed ends); and the surface is more closely and regularly pitted. It is $\frac{1}{45}$ inch in length.

It was discovered by Mr. John Young in the Carboniferous-Limestone series, at Brockley, Lanarkshire. We have also met with it in a washing of shale from Woodend Quarry, Lowick, Northumberland, kindly sent us by Mr. James Bennie.

36. *Argillæcia æqualis*, J. & K.
(Pl. IX. figs. 6 *a*, 6 *b*.)

Argillæcia æqualis, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Elongate, compressed, nearly equal in height thoughout, and with equal ends; dorsal border flatly arched; ventral border straight or slightly convex; anterior extremity rather higher and less projecting than the other; lateral contour elliptical, widest in the centre; right valve largest and overlapping the left; surface smooth; shell thick. Length $\frac{1}{25}$ to $\frac{1}{22}$ inch.

In most specimens this species is a trifle highest in front;

though in others there is no difference observable, and the ends are about alike.

In general form it has so much the character of recent *Argillœciœ* that we place it in that genus, with the approval of our friend Prof. G. S. Brady.

It is not the same species as D'Eichwald's *Bairdia œqualis*, which has more the appearance of a *Bairdia*.

Arg. œqualis is essentially a Lower-Carboniferous form, though it apparently occurs rarely in the lower beds of the Carboniferous-Limestone series.

Localities. Calciferous Limestone: Randerstone, Fifeshire; Linnhouse Water (opposite Oakbank Oil-works), Linlithgowshire; Heads of Ayr, Ayrshire; Larriston Quarry (Newcastletown), Roxburghshire; Plashetts and Warksburn, Northumberland.

Carboniferous Limestone: Arnside, Westmoreland; New Rake, Grassington Mine, Yorkshire. Carboniferous-Limestone series: Wilkieson ?, Fifeshire.

37. *Aglaia* (?) *cypridiformis*, J. & K.
(Pl. IX. figs. 7 *a*, 7 *b*.)

Cythere cypridiformis, J. & K., MS. 1880, Quart. Journ. Geol. Soc. vol. xxxvi. p. 588.

Elongate-reniform, nearly of equal height before and behind, valves moderately convex; dorsal border very flatly arched; ventral border slightly incurved; extremities rounded and rather alike; lateral contour elongate-oval, widest in the centre; right valve rather the largest; surface smooth. Length $\frac{1}{25}$ inch.

This rare species is confined to the Lower Carboniferous.

Localities. Calciferous Sandstone: Randerstone, Fifeshire; Tweeden Burn, Roxburghshire; Glencartholm (River Esk), Dumfriesshire; Plashetts, Northumberland.

38. *Xestoleberis* (?) *subcorbuloides*, J. & K.
(Pl. IX. figs. 8 *a*, 8 *b*.)

Xestoleberis subcorbuloides, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Elongate, suboblong, very tumid; dorsal border flatly convex, sloping at extremities; ventral border straight; extremities rounded, the anterior least in height; left valve larger than right; lateral contour ovate or obtusely cuneiform, and of great width at posterior third; shell thick; surface smooth. Length $\frac{1}{35}$ inch.

We refer this species to *Xestoleberis*, because it much re-

sembles it in general habit. *Cythere corbuloides* *, Jones & Holl, from Silurian strata, seems to be a related form †.

Locality. In the Scar Limestone, north of Storr Moss (near Silverdale Station), Lancashire.

39. *Macrocypris carbonica*, G. S. Brady, MS.
(Pl. IX. figs. 9 *a*, 9 *b*.)

Subtrigonal, highest (and gibbous) behind, convex; dorsal border very convex, with a long anterior and a short abrupt posterior slope; anterior extremity rounded; posterior low and subacute; lateral contour elongately subovate, pointed in front and wide behind; right valve largest, and overlapping the dorsal and ventral margins of left valve; surface smooth. Length $\frac{1}{22}$ inch.

This form was figured in a paper on *Carbonia* as a doubtful variety of *C. fabulina*, J. & K.‡. Prof. G. S. Brady has since examined specimens of it for Mr. John Young (who discovered the species), and has named it as above. We are glad to adopt this view of the matter, and on such good authority.

Mr. Young informs us that it occurs, along with *Carbonia fabulina*, and fish and plant remains, in the Millburn beds at Campsie, Stirlingshire.

40. *Carbonia Wardiana*, sp. nov.
(Pl. IX. figs. 10 *a*, 10 *b*.)

Elongately suboval, convex; dorsal border regularly arched; ventral border straight, curving up to form the extremities; one extremity a little more pointed than the other; lateral contour subovate, pointed anteriorly; surface covered with closely-set, irregular, fine striæ or wrinkles; traces of a slightly sunken circular muscle-spot (on some examples). Length $\frac{1}{22}$ inch.

Specimens of this species were sent us by Mr. John Ward, F.G.S., of Longton, from a limestone of the Upper Coal-measures of North Staffordshire. These specimens, being in a hard matrix, are not very easy to make out; but the species evidently comes near to *Carbonia Agnes*, Jones, from the South-Wales coalfield.

* Ann. & Mag. Nat. Hist. 1869, ser. 4, vol. iii. p. 211, pl. xiv. figs. 4 *a*–5 *b*.

† Var. *inflata* of *Carbonia fabulina* also simulates this species in some of its features.

‡ Ann. & Mag. Nat. Hist. 1879, ser. 5, vol. iv. p. 31, pl. ii. fig. 24.

41. *Cythere superba*, J. & K. (Pl. IX. fig. 11.)

Cythere superba, J. & K., MS. 1880, Quart. Journ. Geol. Soc. vol. xxxvi. p. 588.

Large, oval or subovate, rather oblique; dorsal border straight; ventral border slightly incurved; anterior extremity rounded; posterior rounded and higher than the other; both extremities angular dorsally; valves convex or compressed, rimmed, the right larger than the left and overlapping it moderately on free margins; lateral contour compressed-oval, with pointed ends, or elliptical; surface smooth in most cases, in others faintly punctate. Length $\frac{1}{12}$ inch.

This fine species requires several figures to illustrate it properly, as it varies much in outline and convexity. Many examples are tumid and big-bellied, others are comparatively thin; hence there are great differences in the outlines of lateral contour (as seen from above or below) and end views. Some casts show traces of a circular muscle-spot; but we have never observed anything like the eye-spot of *Leperditia*, though in some of its forms this species has much the style of that genus.

It is confined to the Calciferous Sandstones.

Localities. Buddo Ness, Billow Ness, east of Pittenweem, and Craigkelly Quarry, Fifeshire; Oakbank Sandstone Quarry, Linlithgowshire.

42. *Cythere* (?) *obtusa*, sp. nov. (Pl. IX. figs. 12 *a*, 12 *b*.)

Subovate (almost subpentagonal), highest behind, convex; dorsal border short and straight, ventral convex; extremities rounded, posterior largest; right valve largest and overlapping the left on the free margin; lateral contour suboval, widest in centre; surface smooth. Length $\frac{1}{35}$ inch.

This species is probably not a *Cythere*, though now placed in that genus until more is known about it. Two examples only of it were found in a washing of shale from Woodend Quarry (Lowick), Northumberland, sent us by Mr. James Bennie.

This is not the *Cythere obtusa* mentioned in the list of Ostracoda in 'Catalogue of Western-Scottish Fossils' (p. 44); the species to which that name refers is a *Cytherella*—*C. concinna*, J., K., & B. (Monogr. Foss. Entom., Palæont. Soc. 1884, p. 71).

43. *Bairdia legumen*, J. & K. (Pl. IX. figs. 13 *a*, 13 *b*.)

Bairdia legumen, J. & K., MS. 1885, Geol. Mag. dec. 3, vol. ii. p. 540.

Elongate, subpentagonal, high in front, low and acuminate behind; dorsal border subangulate; ventral border faintly

incurved; anterior extremity high and truncated inwardly; posterior extremity acute, rostrate; lateral contour elliptical, widest just in front of centre; surface smooth. Length $\frac{1}{23}$ inch.

This is probably the same species as that represented by fig. 7, pl. xxxii., in our paper on *Bairdia* *. Its nearest allies seem to be *B. amputata*, K., *B. nitida*, J. & K., and *B. submucronata*, J. & K., when ranging beyond their typical forms.

Localities. In Carboniferous-Limestone series, at Cowden Quarry, Fifeshire; in Yoredale rocks, at Gleaston Castle, Lancashire; in Scar Limestone, at Arnside and Sandside, Westmoreland.

44. *Bairdia subelongata*, J. & K., var. *major*.
(Pl. IX. fig. 14.)

This is a very large *Bairdia*, somewhat crushed by pressure. It has rather the shape that a big *B. subelongata* might take if squeezed flat, and we put it as a variety of that species.

It is about $\frac{1}{9}$ inch in length, elongate, with straight dorsal and ventral borders, with the anterior extremity high and evenly rounded, and the posterior low and subacute; the surface is smooth.

It occurs in the Carboniferous-Limestone series at Barmoor Redhouse (Lowick), Northumberland.

As intimated at the beginning of this paper, the foregoing descriptions of species are necessarily very brief and rather incomplete. In some cases little more can be said until the species shall have been better known. With other species we have already material enough to allow of fuller accounts being given, and this we hope by-and-by to do, either in these pages or elsewhere.

It will have been seen how much we are indebted to various friends for assistance in specimens; and though their names have been repeatedly mentioned in this and former pages, we must again express our thanks, especially to our old friends Mr. John Young, of the Hunterian Museum, Glasgow, and Mr. James Bennie, of the Geological Survey, Edinburgh.

EXPLANATION OF THE PLATES.

Plate VI.

[All the figures magnified about 25 diameters.]

Fig. 1. *Bythocypris Phillipsiana*, J. & H., var. *carbonica*, J. & K. *a*, right valve; *b*, end view.

* Quart. Journ. Geol. Soc. 1879, vol. xxxv. p. 565.

Fig. 2. The same. *a,* left valve; *b,* ventral view.
Fig. 3. *Bythocypris* (?) *cuneola,* J. & K. *a,* right valve; *b,* ventral view; *c,* dorsal view.
Fig. 4. The same. *a,* left valve; *b,* end view.
Fig. 5. The same. Right valve, with postero-ventral spine.
Fig. 6. The same. Right valve, showing central spot.
Fig. 7. The same? (variety?). *a,* right valve; *b,* dorsal view.
Fig. 8. *Bythocypris* (?) *cornigera,* J. & K. *a,* left valve; *b,* dorsal view; *c,* end view.
Fig. 9. The same. Right valve.
Fig. 10. *Bythocypris* (?) *pyrula,* J. & K. *a,* left (?) valve; *b,* ventral view; *c,* end view.
Fig. 11. The same. Right (?) valve.
Fig. 12. *Bythocypris* (?) *Moorei,* J. & K. *a,* right (?) valve; *b,* edge view; *c,* end view.
Fig. 13. *Bythocypris* (?) *thraso,* J. & K. *a,* right valve; *b,* dorsal view.
Fig. 14. *Cythere* (?) *gyripunctata,* J. & K. *a,* right valve; *b,* dorsal view.
Fig. 15. *Bythocypris lunata,* J. & K. *a,* side view; *b,* edge view.

Plate VII.

[All the figures magnified about 25 diameters.]

Fig. 1. *Leperditia Armstrongiana,* J. & K. *a,* left valve, Storr Moss; *b,* dorsal view (cast), Law Quarry, Ayrshire.
Fig. 2. *Leperditia Bosquetiana,* J. & K. *a,* left valve; *b,* dorsal view; *c,* end view. Campbelltown.
Fig. 3. *Leperditia Youngiana,* J. & K. *a,* right valve; *b,* ventral view; *c,* dorsal view. Dalry, Ayrshire.
Fig. 4. *Leperditia scotoburdigalensis* (Hibbert). *a,* left valve; *b,* dorsal view. West of Pittenweem, Fife.
Fig. 5. *Leperditia parallela,* J. & K. *a,* right valve; *b,* edge view. Near Bristol.
Fig. 6. *Leperditia obesa,* J. & K. *a,* left valve; *b,* ventral view. Arnside.
Fig. 7. *Leperditia compressa,* J. & K. *a,* left valve; *b,* ventral view. Craigenglen.
Fig. 8. *Leperditia lovicensis,* J. & K. *a,* left valve; *b,* ventral view. Woodend, Lowick.
Fig. 9. *Leperditia acuta,* J. & K. Left valve. Arnside.

Plate VIII.

[All the figures magnified about 25 diameters.]

Fig. 1. *Beyrichia radiata,* J. & K. Right valve of a tuberculated variety. Geol. Surv. Scotland Coll. B 2831 E.
Fig. 2. The same. *a,* left valve; *b,* ventral view. } Cam Beck.
Fig. 3. *Beyrichia longispina,* J. & K. Left valve. }
Figs. 4 & 5. *Beyrichia fodicata,* J. & K. Right valves. } Linlithgow Bridge.
Fig. 6. The same. Left valve. }
Fig. 7. *Beyrichia tuberculospinosa,* J. & K. Left valve. } Murrayfield.
Fig. 8. The same. Right valve. }
Fig. 9. *Beyrichia multiloba,* J. & K. *a,* right valve; *b,* left valve; *c,* ventral view. Mouse Water, Wilsontown.

Figs. 10 & 11. *Beyrichia varicosa,* J. & K. Side views of right and left valves. Whitebaulks.
Fig. 12. *Beyrichia* (?) *bicæsa,* J. & K. Right valve. } Woodhill.
Fig. 13. The same. Left valve. }
Fig. 14. *Primitia* (?) *Holliana,* J. & K. *a,* left valve; *b,* right valve; *c,* ventral view. Great Ormes Head, Caernarvonshire.
Fig. 15. *Beyrichiella* (?) *reticosa,* J. & K. Right valve. Abden, Fife.
Fig. 16. The same. *a,* left valve; *b,* dorsal view; *c,* ventral view. Whitebaulks, Linlithgowshire.
Fig. 17. *Beyrichiella* (?) *ventricornis,* J. & K. Right valve. Robroystone.
Fig. 18. The same. *a,* left valve; *b,* ventral view; *c,* end view. Charlestown, Fife.
Fig. 19. *Kirkbya tricollina,* J. & K. Right valve. Arnside.
Fig. 20. *Moorea obesa,* J. & K. *a,* side view; *b,* ventral view. Brocastle, South Wales.
Fig. 21. *Moorea tenuis,* J. & K. *a,* side view; *b,* ventral view. Mendips.
Fig. 22. *Cytherella* (?) *reticulosa,* J. & K. *a,* side view; *b,* edge view. Storr Moss.
Fig. 23. The same. Internal cast, showing the muscle-spot. Storr Moss.

Plate IX.

[All figures magnified about 25 diameters.]

Fig. 1. *Cytherella valida,* J. & K., var. *affiliata,* nov. *a,* left valve; *b,* dorsal view. Gleaston Castle.
Fig. 2. *Cytherella* (?) *elongata,* J. & K. Left valve. } Murrayfield.
Fig. 3. The same. Right valve. }
Fig. 4. *Bythocythere Youngiana,* J. & K. *a,* left valve; *b,* dorsal view. Woodend Quarry, Lowick.
Fig. 5. *Bythocythere antiqua,* J. & K. *a,* left valve; *b,* dorsal view. Skellygate.
Fig. 6. *Argillœcia æqualis,* J. & K. *a,* left valve; *b,* ventral view. Larriston.
Fig. 7. *Aglaia* (?) *cypridiformis,* J. & K. *a,* left valve; *b,* ventral view. Plashetts.
Fig. 8. *Xestoleberis* (?) *subcorbuloides,* J. & K. *a,* right valve; *b,* ventral view. Near Storr Moss.
Fig. 9. *Macrocypris carbonica,* G. S. Brady. *a,* left valve; *b,* dorsal view. (After Brady.) Millburn, Campsie.
Fig. 10. *Carbonia Wardiana,* J. & K. *a,* side view; *b,* edge view. Longton, Staffordshire.
Fig. 11. *Cythere* (?) *superba,* J. & K. Carapace, showing the right valve. Craigkelly.
Fig. 12. *Cythere* (?) *obtusa,* J. & K. *a,* carapace, side view; *b,* ventral view. Woodend, Lowick.
Fig. 13. *Bairdia legumen,* J. & K. *a,* right valve; *b,* dorsal view. Gleaston Castle.
Fig. 14. *Bairdia subelongata,* J. & K., var. *major,* nov. Left valve. Barmoor Redhouse, Lowick.

XXVII.—*Description of a new Species of* Lamellaria *from South Australia.* By EDGAR A. SMITH.

Lamellaria Wilsoni.

Testa magna, ovata, bulimiformis, tenuis, epidermide tenui, membranacea, lactea, lineis incrementi distinctis undulatis striata induta; anfractus tres, convexi, rapide accrescentes, sutura anguste canaliculata sejuncti; spira ad apicem obtusa; anfr. ultimus amplissimus; apertura ovato-pyriformis, inferne recedens, intus albida, inusitate magna; peristoma tenuissimum, membranaceum, statu sicco rugosum; margo columellaris tenuis, arcuatus, labro callo, tenuissimo, albo superne junctus.

Longit. 37 millim., diam. max. 28, apertura 28 longa, 17 lata.

The animal of this species (in spirit) is globose, fleshy, of a dirty yellowish colour, and marked at irregular distances with conspicuous coal-black spots of different sizes and shapes. The mantle over the back investing the shell is very thick and fleshy. The foot, which is much contracted, appears to be squarish in front and a little tapering behind, and has the usual groove across the anterior end, forming as it were a double margin. The tentacles in the contracted state are short, not tapering, rather compressed, and have small prominences at the outer bases bearing the minute eyes. Buccal mass globular, with the flat horny jaw-plates strongly serrated at the edge. Odontophore long and broad, bearing eighty-eight rows of teeth. Each row consists of a small conical central tooth, having on each side a rather smaller one of a somewhat different shape, and two laterals (uncini), both of which are much hooked and very acute, the outer one being considerably smaller than the inner. None of the teeth, either centrals or laterals, are serrated along the edges.

From the above description it will be seen that this fine species differs in some respects from the type of the genus both as regards the shell and the animal. The shell has a much less open mouth, and the spire is proportionally larger in comparison with the body-whorl. The lingual ribbon is different in detail from any of the sections into which this genus has been subdivided, the non-serrate character of the teeth being very peculiar. The shell most resembles that of *Lamellaria*, but the dentition more nearly approaches that of *Marsenina.*

The single specimen in the Museum was presented by

J. B. Wilson, Esq., together with numerous other interesting marine Invertebrata. It was dredged in Port Phillip Bay, South Australia.

The annexed woodcut represents the shell one half the natural size and a greatly magnified view of one of the transverse series of the lingual teeth.

XXVIII.—*Supplement to the Descriptions of Mr. J. Bracebridge Wilson's Australian Sponges.* By H. J. Carter, F.R.S. &c.

[Plate X.]

Having finished the description of Mr. J. Bracebridge Wilson's Australian Sponges which came to me in his first consignments, I have now to add in the following "Supplement" descriptions of those which have been received since, and further to supply any omissions and corrections that may be necessary in what has already been published, including replies to objections that have been made to any parts of the latter.

Taking the orders again as they stand in my Classificatory Arrangement of 1875 ('Annals,' vol. xvi. p. 131 &c.), I would observe that the plan adopted latterly in my descriptions of these Australian Sponges, viz. that of inserting a copy of the tabular view of this arrangement for more convenient reference at the commencement of each order, was omitted in the Carnosa and Ceratina; hence this will now be supplied.

Order I. CARNOSA.

Fam. 1. **Halisarcida.**

Char. Possessing no spicules.

Fam. 2. **Gumminida.**

Char. Possessing spicules.

I also omitted to note what I had written on the subject, viz. a paper on all the then-known species of Carnosa, in the 'Annals' of 1881 (vol. viii. p. 241 and "Addendum," p. 450).

To this I would add the illustrated observations of Prof. F. E. Schulze on the development of the species of *Halisarca*, the *family* of the Chondrosidæ, and *Corticium candelabrum* respectively (Zeitschrift f. wiss. Zoologie, Bde. xxviii. and xxix. of 1877 and Bd. xxxv. of 1881); also Dr. R. v. Lendenfeld's "Preliminary Report on the Australian Myxospongiæ" (Proc. Linn. Soc. N. S. Wales, vol. x. pt. 1, p. 139, pls. i.–v.).

With reference to my account of "*Halisarca australiensis*" in the 'Annals' of 1885 (vol. xv. p. 196), Dr. v. Lendenfeld has stated (*ib.* vol. xvi. p. 21) that "it is not a sponge at all, but the crusts described by Carter under the above name are the ova of *Boltenias* surrounded by their folliculi;" which, *ab initio*, may be refuted by simply drying a piece of the stem of a *Boltenia* with a portion of the crust on, when the latter will be found to be homogeneous in structure, like dry glue, and the former heterogeneous (that is, the cartilage of which the stem is composed), more or less charged with the cells, which Dr. Lendenfeld appears to me to have mistaken for "folliculi" of the *Boltenia*.

If, now, we go further, and examine a portion of the ovary of the Ascidian itself, it will be found that the ripening of the ova for expulsion takes place *successively*, so that the whole is not discharged at once in a mass, like the spawn of Gasteropods &c., and therefore could not form a "crust" on the stem of the *Boltenia*.

While if sections be made of the "crust" when fresh or undried, it will be found to contain no appearance of ova whatever, but, on the contrary (especially when stained), will be found to present pores on the surface leading into elongated chambers, followed by the ampullaceous sacs (Geisselkammern) themselves; thus, independently of the dried condition, proving at once that the crust on the stem of *Boltenia australiensis* is not the spawn of an Ascidian, even if there were such a thing, but a *bonâ fide* Halisarcous sponge.

Having had to repeat my examination of this "crust," together with that of the other specimens of *Halisarca australiensis* whose characters were originally included under this heading, it now seems to me that in my description I have mixed up at least *three* forms, which might be more conveniently divided into *Halisarca australiensis*, *H. ascidiarum*, and *H. reticulata*, since the solidity of the former, the incrusting character of that on the stem of *Boltenia australiensis*, and the strongly marked reticulated structure of the surface of the latter, if not specifically distinct, are so varietally.

Taking them separately, then, they may be distinguished thus :—

Halisarca australiensis.

Massive, cuboidal or plano-convex, spreading, growing over the detritus of the sea-bed of the locality (agglomerated sand and shells), or unattached and free; following no particular shape, but generally more or less round and lobed. Consistence doughy. Colour grey or brown. Surface very smooth, puckered here and there, presenting under the microscope a thin layer of small epithelial cells, covering a soft fibro-reticulated structure, whose interstices represent the subdermal cavities. Pores in the epithelial layer over the interstices. Vents single, here and there on the smooth parts and in the puckered depressions respectively. Structure (as seen in the vertical section) commencing from the outside with the thin layer of epithelium, followed by the soft reticulated structure, into whose interstices the pores open, and then the body-substance, more or less traversed by lacunæ and the canals of the excretory systems, whose forms, whether vertical and crevice-like or oblique and transverse, are influenced by the line of section, surrounded more or less radiatingly by aggregations of ampullaceous sacs, which are subglobular or pyriform. Size of specimens, of which there are several, as variable as their form, but not more than 2 inches in their longest diameter.

Obs. It will therefore be observed that the plan of structure is the same as that of all other sponges. How the particles of nourishment which pass in with the water through the pores are subsequently conveyed to the ampullaceous sacs remains to be shown.

Halisarca ascidiarum.

Incrusting, growing over the surface of sessile as well as stalked Ascidians, more especially over *Boltenia*, seldom more than 1-12th in. in thickness, and presenting a creno-tuberculated or mesenteric form of surface corresponding to that of the subjacent cartilaginous test, but not of the stem, where it is even still more creno-tuberculated, while the stem remains smooth, so that it is probably the form assumed by the *Halisarca* itself. Consistence yielding, like that of soft dough. Colour pinkish or brownish white. Surface very smooth, presenting under the microscope a thin layer of small epithelial cells, covering a soft homogeneous fibro-reticulation, whose interstices represent the subdermal cavities. Pores in the

epithelium covering the interstices. Vents not seen. Structure generally compact, and the parts mentioned in *H. australiensis* so indistinctly and delicately developed that, although evident, I have not been able to make a vertical section in which the forms of the ampullaceous sacs could be satisfactorily seen; still the form, if not identical, appears to be but a variety of *H. australiensis*, chiefly dependent on its habit for its differences. The "creno-tuberculated" state may be an exaggerated form of the puckerings on the surface of this kind of sponge generally.

Halisarca reticulata.

Enveloping with a thin layer the calcareous fronds of Reteporian and Escharidian Polyzoa, uniting through the interstices of the former; varying in thickness under 3-24ths in. Consistence exceedingly tough. Colour whitish grey. Surface smooth, presenting a tough fibro-reticulated structure, with more or less *round* interstices, covered by a thin epithelial layer. Pores in the interstices. Vents here and there indicated in their position by the centres respectively of substellate, branching, superficial, excretory canal-systems in the form of venations, which are seen just below the epithelium. Structure essentially fibrillous throughout, commencing (in the vertical section) with the thin epithelial layer, followed by the fibro-reticulated one, whose tough fibrillæ extending inwards are accompanied by the usual subglobular form of ampullaceous sacs, succeeded in one specimen by the development of small ova, each furnished with a germinal vesicle and its nucleolus or germinal spot, and about 8-6000ths in. in diameter. These are situated in juxtaposition in the midst of a tough fibrillous trama, but each separate and provided with a cell-cavity, which, on being scratched out from the general mass, comes away with the ovum inside it, while the surface of the "cell-cavity" is fringed with filaments which appear to have been in connexion with the fibrillæ of the trama. Size of specimen indefinite, following that of the fronds of the Polyzoon on which it may be growing. There are three large specimens of this species, viz. one from "Port Phillip Heads" and the other two from "Port Western," all growing on the same kind of Polyzoa, and all presenting the same characters, which, from the strongly marked and tough retiform fibre-structure of the surface, has been designated "*reticulata*." It is totally different from either of the foregoing forms in this respect and from every other species of this order that I have seen, so that I am in doubt whether it

should not be made the type of a new genus, in which case the generic name would have to be changed.

There is still another species among the specimens from "Port Western," which may be characterized under the following name:—

Halisarca tessellata.

In every respect this is like the brown-coloured specimens of *H. australiensis* from the same locality; but the surface presents a fibro-reticulated arrangement, in which the interstices are characteristically *polygonal*, although variable in size and number of sides. The margin (in the vertical section) presents a uniform succession of translucent separated spaces, which correspond with the vertically cut ends of the dermal fibro-reticulation, and the ampullaceous sacs are almost *linear* in form, that is ten times longer than they are broad.

Besides the difference in consistence generally the dermal fibro-reticulation, although like that of *H. reticulata*, is not accompanied by *circular* or elliptical interstices, as in the latter, but by polygonal ones, as above stated. The succession of transparent spaces in the vertical section of the margin is more uniform, and the ampullaceous sacs are *linear*, and not subglobular or pyriform.

Notwithstanding this difference in the form of the ampullaceous sacs, some of the latter, when viewed in the vertical section of the *other* species, occasionally appear to be much more narrow than the rest, hence considerably resembling the form of those in *H. tessellata.* This, however, it should be remembered may depend on the line of section, which, if passing through the *short* diameter of a compressed pyriform ampullaceous sac, would give the *linear* form. Hence it, with many more questions of a like nature, in all these species should be worked out more satisfactorily, since in this necessarily hasty sketch I am only able to direct attention to the existence in the localities mentioned of species of the CARNOSA, to which it is desirable to give more extended examination.

All the structure of *Halisarca australiensis* may be seen in *Halisarca Dujardini* when the latter is fresh, only being more delicate it is not so strongly marked, in short not so strongly developed, in the British species; and if *H. lobularis* were covered with a cortical layer it would, in like manner, present the same appearance, for the most remarkable part of this sponge is its *active ciliated surface.*

Here I might add that the species of *Halisarca* described

and illustrated by Merejkowsky under the name of "*H. Schulzii*" (Mém. Acad. Sc. St. Pétersb. 1878, tome xxvi. no. 7, pl. i. figs. 1–6, and pl. ii. figs. 9–15) appears to me to be no other than *Halisarca Dujardini*, which is as abundant on the rocks and *Fuci* at Budleigh-Salterton (S. Devon) at "half-tides" as in the "White Sea."

In 1874 I gathered some branches of the small *Fuci* here bearing specimens of this sponge, and put them at once, that is on the spot, into some sea-water containing indigo paint in solution, in order to see if the sponges took in the latter, which was the case; so I placed the whole in spirit for preservation. Now (in 1886), finding that Merejkowsky had discovered certain "glands" in his species (*l. c.* p. 32, pl. ii. fig. 9 *b*), and conceiving that it was the same as *H. Dujardini*, I gently raised one of the specimens (about 1-12th in. in diameter) from the frond of the *Fucus* to which I have alluded, and placing it in a microscope-cell filled with *glycerine*, brought it under a magnifying-power of about 300 diameters, when, to my great delight, I saw the cells which Merejkowsky had described and represented, particularly as he has stated, viz. about the "osculum" (p. 33), which, projecting from one side of the object, is in a very favourable position for observations of this kind, that is by transmitted light. Moreover, as the spongozoa had become coloured by the indigo, while not a particle was to be seen in these bodies, termed by Merejkowsky "glands," it is evident that the latter at least are not for *nutrient* purposes.

After this I stripped off a bit of the dermis from one of Mr. Wilson's specimens of *Halisarca australiensis*, and having stained it with blue ink, also mounted this in a "cell" with *glycerine*, when a similar layer of bodies became equally evident, *mutatis mutandis* of course, that is with more strongly marked fibrous structure than in *H. Dujardini*, so that the difference between the two was rather quantitative than qualitative, as before explained.

Similar bodies in his *Dendrilla rosea* &c., from the south coast of Australia, were described and represented by Dr. v. Lendenfeld in 1883 (Zeitschrift f. wiss. Zoologie, Bd. xxxviii. p. 278, pl. xii. fig. 21 *d*), and by Dr. Polèjaeff in 1884 ('Challenger' Reports, vol. xi. pt. xxxi. KERATOZOA, p. 40, pl. ii. fig. 5), in *Ianthella*, &c. So that the existence of these organs is well established and probably their function, that which Merejkowsky originally assigned to them, viz. "unicellular glands," which secrete the "viscous" matter of the surface (*l. c.* p. 34).

Lastly I would allude to the following variety of *Halisarca australiensis* in Mr. Wilson's collection from "Port Western," which might be designated

Halisarca australiensis, var. *arenacea*.

It is much lighter in colour than the rest, owing probably to the presence of quartz-sand, with which it is abundantly charged, thus affording another instance of what occurs in *Gummina gliricauda*, Sdt., &c., whose consistence, viz. that of soft caoutchouc or india-rubber, is similar to that of *Halisarca australiensis* (see my paper on the CARNOSA, *op. et loc. cit.* p. 248, respecting this sand in the Halisarcida).

Chondrilla nucula, Sdt.

I have already alluded to the specimen of this species which came from "Port Phillip Heads" ('Annals,' *l.c.*), in the description of which, however, the size of the globostellate spicules, which I now find to average 4-6000ths in. in diameter, is not mentioned. This is the size also of the globostellates in two other specimens from "Port Western," one of which, growing upon and half imbedding large fragments of mussel-shells, is $4\frac{1}{2}$ in. long by $1\frac{1}{2}$ in. in diameter more or less, being irregularly cylindrical in shape, and bearing the usual minute papillæ charged with globostellates on its surface; varying in size under 1-160th in. in diameter, and about the same distance apart.

Chondrilla secunda, Lendenfeld.

Chondrilla secunda, Lendenfeld, Proc. Linn. Soc. N. S. Wales, vol. x. pt. i. p. 151, figs. 10–12.

Specimen flat or only slightly convex; sessile throughout; growing on the calcareous test of a Polyzoon. Colour light yellowish brown. Surface even, smooth, like glass, minutely granulated. Pores plentifully scattered over the surface. Vent single, situated towards one end of the specimen. Structure internally consisting of a brownish, pulpy, elastic tissue, surrounded by a thick, rigid, cartilaginous cortex, through which (in the vertical section) the pores may be seen to descend, increasing in size towards the usual interlobular lacunose crevices of the body. Spicule of one kind only, viz. globostellate, of different sizes under 18-6000ths in. in diameter, whose spines may be sharp-pointed or obtuse. Chiefly aggregated towards the surface, where, together with a great number of pigment-cells, they respectively add to the consist-

ence and dark colour of the cortex produced by the latter. Size of specimen 11-12ths × 7-12ths in. horizontally and 4-12ths in. high in the centre.

Loc. Port Western.

Obs. To this variety of *Chondrilla nucula* Dr. v. Lendenfeld has given the above name. My specimen does not appear to contain the smaller stelliform spicules which he has represented (*l. c.*).

Chondrilla papillata, Lend.

Chondrilla papillata, Lend. *op. et loc. cit.* p. 153, figs. 13–16.

Specimen irregularly elliptical, flattish, convex, contracted towards the base, which had been attached to the calcareous test of a Polyzoon. Colour greenish or greyish stone. Surface papillated over the upper part, becoming smooth beneath; papillæ hemispherical, in strong relief, in juxtaposition, and averaging 1-66th in. in diameter at the base, smooth and slippery, but minutely granulated. Pores on the surface, not well seen. Vents three in number, situated respectively in the deep, puckered, crevice-like depressions usually present, as before stated, on the surface of such sponges, the largest presenting at the bottom a cribriform structure that represents the openings of several excretory canals which empty themselves at this point. Structure internally consisting of a thick rigid cortex, about 1-48th in. in diameter including the papillæ, surrounding a lighter-coloured, elastic, pulpy tissue, presenting the usual crevice-like lacunose vacuities, decreasing in size towards the circumference, where they become subdivided and thus end in the pores. Spicule of one form only, viz. globostellate, in which the spines are pointed, globostellate, comparatively small, averaging 4-6000ths in. in diameter; chiefly congregated in the papillæ, where they form the granulated surface, and, together with an abundance of pigmental cells, add respectively to the consistence and colour of the cortex. Size of specimen about 4-12ths × 7-12ths in. horizontally, and 4-12ths in. high.

Loc. Port Western.

Obs. In this specimen also I did not see any of the stelliform spicules represented by Dr. v. Lendenfeld, although there can be no doubt that it is the same species as that which he has described and illustrated under the above name.

As regards the diameter of the "globostellates" in different species of *Chondrilla*, I find that in *C. nucula*, Sdt., it is 7-6000ths; in *C. australiensis*, Cart., 7-6000ths; in the

specimens of *C. nucula* from "Port Phillip Heads" &c. 4-6000ths; in *C. secunda*, Lend., 18-6000ths; in *C. sacciformis*, Cart. (Mauritius), 27-6000ths; and in *C. papillata*, Lend., 4-6000ths.

I omitted to mention that in all the *Chondrillæ* there appears to be a horizontal, more or less interrupted cavity traversed by filaments between the cortex and the body, like the subdermal cavities of sponges generally, which not only marks the division between the two, where they are easily separable, but into which the pores empty themselves before their contents are continued on to the interior of the body.

Such a line of demarcation does not appear in the varieties of *Halisarca* above mentioned.

Order II. CERATINA.

Having also in my descriptions of the Australian species in this order, which have been already published, omitted to premise, for more convenient reference, the classificatory arrangement of 1875, it is herewith supplied as tabulated at p. 188 (*op. et loc. cit.*).

Fam. 1. **Luffarida.**
2. **Aplysinida.**
3. **Pseudoceratida.**

For the characters of these "families" respectively I must refer the reader to p. 134 &c. (*l. c.*), where they are given *in extenso*; while I take this opportunity of briefly stating whence the names of the first and second families here have been derived.

In 1794 Esper described and illustrated a species named "*Spongia fistularis*" ('Pflanzenthiere,' vol. ii. tab. 21 *a*), which, in 1816, Lamarck identified with one of the same kind in his "Cabinet" (Anim. sans Vertèbres, tome ii. p. 367); and in 1845, Bowerbank changed the generic name of "*Spongia*" to "*Verongia*" (in honour of Dr. Veronge, who sent the specimen to him), adding the following diagnosis of its fibre, accompanied by equally good illustrations, viz.:—

"Skeleton composed of a network of keratose fibres inosculating in every direction without order. Fibre cylindrical, continuously fistular, without spicula. Cavity of the fibre simple" ('Annals,' vol. xvi. p. 403, pl. xiii. fig. 7), whereby Esper's "*Spongia fistularis*" became *Verongia fistularis*, Bowerbank.

Meanwhile, in 1833, Nardo, in his classification of the

Sponges generally, had made a genus under the name of "*Aplysia*," which, in 1834, he altered into "*Aplysina*;" and, further, divided into two "subgenera," which were respectively characterized by the possession of "flaccid" (*fibris flaccidis*) and "more rigid" (*rigiditatis majoris*) fibres (Isis, Spong. Classificatio), thus establishing structurally their most striking differences, as I can testify by possessing specimens of *Spongia fistularis,* Lam., and *Aplysina*, Sdt., respectively from Nardo's neighbourhood, that is the Mediterranean. Hence it may be inferred that Nardo was acquainted with both forms when he laid down their characters respectively (Venice, 1834). In short, this is certain as regards *Spongia fistularis*, for Ehlers, in 1870, identified Nardo's type specimen in the Museum at Erlangen with "*Verongia fistularis*," Bk. (Esperschen Spongien &c.).

In 1864, De Fonbressin and Michelotti made a "tribe" of the "more rigid" of these sponges under the name of "SPONG. HOMOGENÆ," wherein they were classed under one genus named "*Luffaria*" (Spongiaires de la Mer Caraïbe, p. 58); while Schmidt, in 1870, pointed out, by description and illustration, that which Nardo had done in 1834, only in different terms, viz. the distinction between *Spongia fistularis* and *Aplysina* (Atlantisch. Spongienf. p. 30, Taf. iii. figs. 15 and 16, respectively), accepting at the same time De Fonbressin and Michelotti's name of "*Luffaria*" for the former.

It therefore seems evident that Nardo's first subgenus, viz. "*Aplysinæ spongeliæ*," constitute my "Aplysinida;" and that his second subgenus, viz. "*Aplysinæ velariæ*," = *Spongia fistularis,* Esper (altered generically to "*Verongia*" by Bowerbank, and subsequently, without any allusion to the latter, by De Fonbressin and Michelotti to "*Luffaria*," which term was accepted by Schmidt also without any allusion to Bowerbank's name), forms my "Luffarida."

Hence, in matter of nomenclatural precedence and custom I should have used the term "Verongida" for the family, but having unconsciously adopted that of "Luffarida" after Schmidt for such sponges, in my classification, "*Verongia*," as originally instituted, must now come in as a genus illustrated by "*Verongia fistularis*," as typical of the "Luffarida," unless hereafter it may be considered proper to discharge the latter altogether. It is not necessary that a family name should be based upon that of any particular genus in that family, if upon any at all, for many genera may be formed upon single species by different people and under different names, which finally some one may consider it desirable to place in one family under his own name.

But to return to the more legitimate object of this communication, it may be stated that, in 1881, I published a paper on the "CERATINA," in which some new species were described and illustrated, together with observations on the development of the "fibre" ('Annals,' vol. viii. pp. 101 and 113, respectively, pl. ix.); and in 1882 other species from the West Indies were added (*ib.* vol. ix. p. 268 &c.). Since which nothing occurred to cause me to return to the subject until the arrival of Mr. Wilson's sponges from "Port Phillip Heads" in 1885, to the descriptions of which I have now to add the following supplement.

Dendrilla rosea, Lendenfeld, var. *digitata*, Cart.

With reference to the specimen which I described in 1885, under the name of "*Luffaria digitata*" ('Annals,' vol. xv. p. 201), I now find on reexamination of it, aided by Dr. R. v. Lendenfeld's valuable description and illustrations (Zeitschrift f. wiss. Zoologie, Bd. xxxviii. p. 271, Taf. x. figs. 3 and 4, a copy of which he kindly sent me), that it is not a "*Luffaria*," but an "*Aplysina*" (following Schmidt's distinctive characters); still, the designation "*digitata*" applies to my form, which is that with which, through Mr. Wilson's specimens, I am most familiar, better than to that of Dr. Lendenfeld's typical illustration, although they both present the same dendritic, *un*anastomosing character of the fibrous skeleton, of which therefore mine can only be considered a variety, as above designated.

Nothing can be more striking than the differences in structure of the Luffarida and the Aplysinida (which certainly I overlooked in the present instance), inasmuch as the fibre of the former is unyielding and almost wiry in consistence, both wet and dry, with a continuous, anastomosing, central, tubiform core; while in the latter it is more or less flaccid with an *un*anatomosing core. The course of the core, too, in Luffarida is uniform, while in the Aplysinida it is interrupted transversely by parabolical lines of growth, which apparently is an unfailing sign of the fibre.

Of the Luffarida there is an abundance of specimens in the British Museum, viz. tubular and cylindrical, branched and solid respectively, many of which are very large, *ex. gr.* the specimen from the Gulf of Honduras, described under the name of "*Luffaria Archeri*" by Mr. Th. H. Higgin, F.L.S. ('Annals,' 1875, vol. xvi. p. 223), which is a curved trumpet-shaped tube, 3 ft. 9 in. long, and 5 in. in diameter at the free end. Most of these specimens come from the West Indies, but there are others in the collection which were purchased

from the executors of the late Dr. Bowerbank, labelled "S. Australia," and also one in spirit from the island of Crete, in the Levant, which was obtained and presented to the Museum by Admiral Spratt, who surveyed this island. But of the Aplysinida there are very few specimens indeed, perhaps because the flaccidity of their skeletons, when dry, gives them such a worthless aspect.

Thinking that Prof. A. Hyatt's "Dendrospongia" might be very nearly allied to *Dendrilla rosea*, if not the same, I sent him the skeleton of a digitated macerated specimen for comparison, and received from him in reply the following, viz., "*Dendrilla* is quite different from *Dendrospongia*; the latter never has a trunk of fibres;" together with a type specimen of the latter confirmative of his statement.

The keratose skeleton of the specimen which I described in 1885 (*l. c.*) is 9 in. high, and of a light brown-amber colour, commencing from a root-like expansion of individual fibres which become gathered together spirally into a short stem nearly as broad as it is long, viz. 7-12ths in., which then divides into several long branches that go on dividing and diminishing in size tree-like, without anastomosing, to the ultimate ends of the filaments that appear at the circumference of the digitations, where the latter often project through the surface, but in their natural state simply elevate into conical points the pink flesh-like fibro-reticulate dermal sarcode with which they are naturally covered; maintaining throughout such a degree of resiliency, toughness, and flexibility that the whole specimen can be squeezed into a large bottle through a narrow neck and taken out repeatedly without breaking.

Besides the specimens of *Dendrilla rosea* there are others in Mr. Wilson's collection from "Port Western" whose skeletons in structure are quite the reverse, as may be seen from the following description of one which, for distinction sake, may be provisionally termed

Aplysina cæspitosa.

Cæspitose, consisting of a great number of short erect branches interuniting in their course upwards from the base to the circumference, so as to form a hemispherical or convex general mass of a pinkish colour. Surface presenting a soft, fleshy, fibro-reticulation like that of *Dendrilla rosea*. Pore-areas occupying the interstices of the reticulation. Vents scattered here and there. Structure sarcodic and fibrous, the former less firm in consistence than that of *Dendrilla rosea*, therefore shrinking up to almost nothing on desiccation; the latter also

commensurately thin and flaccid, although still resilient; consisting of main and lateral branches, the main ones pursuing an irregular course towards the surface without anastomosing, and the lateral ones uniting the main filaments together ladder-like, or through an intervening anastomotic reticulation of their own, whose filaments are fixed to the surface of the main fibre, with the central cavity of which, however, that of the filaments does not communicate. Colour dark amber. The whole, on desiccation, collapsing, from the thinness of the walls, into a flimsy, resilient, skeletal structure. Size of specimens, of which there are two, about 4 in. high by 6 in. in horizontal diameter.

Loc. Port Western.

Obs. The fibre of this species is invaded by a branched reticulated fungus, which traverses its central cavity, and thus renders it identical with Bowerbank's representation of the fibre of his genus "*Auliskia*" ('Annals,' 1845, vol. xvi. p. 405, pl. xiii. fig. 1), in which his "cæcoid canals" are nothing more than the branches of a fungus or a "parasitic alga," as Schmidt has stated long ago (Spongien d. adriat. Meeres, 2nd Suppl. p. 10). It is somewhat curious that of the four genera created by Bowerbank in this paper (*l. c.* p. 400 &c.), viz. *Verongia*, *Auliskia*, *Stematumenia*, and *Cartilospongia*, one only, viz. the first, should be tenable, since "*Auliskia*" is characterized by a parasitic fungus; "*Stematumenia*" also by the presence of a parasite, viz. *Spongiophaga communis*, Cart.; and "*Cartilospongia*," based on the structure of bone in the "body" of a vertebra from a young whale, which may be seen among his specimens now in the British Museum. It is extraordinary that a man of such extensive microscopic experience did not see in his illustrations of the latter (*l. c.* pl. xiv. fig. 6 &c.) the "oat-shaped cavities," the "lacunæ," and the "canaliculi" of osseous structure. Indeed the odour of the specimen when I made a section of it was, without anything else, sufficient to convince me of its nature.

There is another specimen which again, for distinction sake, might be provisionally designated "*massa*," on account of its slightly lobate massive form. I say "provisionally," because there appears to me to be a great variety of Aplysinoid growths in the neighbourhood of "Port Phillip Heads," which possibly (if altogether considered on the spot where they can be easily obtained, as they should be) might be found to be derived from only one or two species. These varieties do not appear to me to be so much in the soft parts as in the colour and structure of the keratose skeleton. Thus in *Aplysina massa* the colour of the fleshy part is dark grey and the

skeletal fibre light brown, as will be seen by the following description; while, as I have before stated, in identical specimens of what I now know to be *Dendrilla rosea* it may be flesh-coloured and grey or colourless respectively.

Aplysina massa.

Massive, slightly lobate, sessile, contracted towards the base. Colour mouse- or dark grey. Surface even, presenting the usual dermal, soft, fibro-reticulation raised into conical points by the ends of the dermal filaments of the subjacent keratose fibre. Pore-areas in the interstices of the reticulation. Vents scattered here and there. Structure fleshy, supported on keratose fibre. Fleshy part more or less cancellated by the canals of the excretory systems; traversed perpendicularly from the circumference by large inhalant "fold-bearing" canals (that is, canals surfaced by transverse folds or sharp ridges of the lining membrane, which, partially encircling the canal in segments of a circle, thus intercross each other's terminations longitudinally like the "*valvulæ conniventes*" of the small intestine), which commence immediately under the cribriform pore-structure of the surface apparently without the intervention of subdermal cavities; hence the situation of their mouths respectively may be seen from the outside, as their dark circular areas loom through the cribriform structure: keratose fibre aplysinoid, of a light-brown colour corresponding with that of the flesh; consisting of large and small filaments, the former arising *singly* in a plurality of points and pursuing an unbranched, *i. e.* undivided, course to their termination, in an attenuated form respectively on the surface; the latter branching off from the former, but not by *division* of the central canal of the larger fibre, as will now be explained.

Having macerated a large portion of this specimen in water, so as to rid the keratose skeleton of all *soft* parts, the skeletal structure was placed between two pieces of glass, with sufficient water to fill up all the vacuities, in which condition it was examined under a low microscopic power, and the apparent branches found to be not divisions of the large fibres, but *additions* to their surfaces respectively, formed by the development of the "horn-cells" of the sarcode thus applied to them. I have already described and illustrated the "horn-cell" and this mode of growth in *Aplysina corneostellata* = *Darwinella* ('Annals,' 1872, vol. x. p. 107, pl. vii. figs. 4 and 5), and in the present instance they were observed to be in great plurality, attached to the outside of the larger fibres,

in all stages of development, viz. from that of simple approximation, followed by a covering composed of several layers of kerasine, to that which afterwards became similarly extended into the usual laminated filament. So that it may fairly be assumed that the first-formed fibres of the skeletal structures throughout originated in this way, viz. from the "horn-cells" attached to the object on which the specimen grew. Size of specimen about 3 in. high by 3 × 2 in. horizontally.

Loc. Port Western.

Obs. There is another specimen of this kind in which the skeleton appears to be more reticulate but formed after the same plan, viz. by "horn-cells" applied to the exterior of the main filaments, and, indeed, so might the skeletal fibres of *Dendrilla rosea* at the commencement, although gathered together afterwards spirally from the root-like expansion into a common trunk; but they do not do so above this, for in the divisions of the *branchlets*, when placed under the microscope, the latter may be seen to arise from a budding-off of the central canal, although the subsequent thickness of the fibre appears to be added by layers of kerasine applied to the exterior, that is by the sarcode, as in *Aplysina massa*.

In *Aplysina massa* too the same kind of large nucleated epithelial cells of the surface, averaging 5-6000ths in. in diameter, are to be found as in *Dendrilla rosea* &c., but accompanied by much smaller granuliferous ones, about 2-6000ths in. in diameter, that appear to be endogenously derived from them, and which, in the blood-red species about to be described, viz. *Aplysina cruor*, are seen to be the pigment-cells or bearers of the red colouring-matter of this species, all of which *first* present themselves as *coloured* granules in the large epithelial cells.

Lastly, the fibre of this species is *also* traversed by a parasite in the form of a branched fungus, which gives it the appearance of Bowerbank's imaginary genus *Auliskia*. The filaments, too, of this organism are often fructiferous.

Aplysina nævus, Carter.

Aplysina nævus, Carter, 'Annals,' 1876, vol. xviii. p. 229, pl. xii. figs. 1 *c* and 2.

Growing over both valves of a large mussel in an incrusting form. Consistence soft. Colour, when fresh, "coffee-brown." Surface presenting the usual soft fibro-reticulated structure, here charged with a few fine, foreign, acerate spicules and supported on the ends of short, skeletal, keratose filaments, arranged vertically, so as to raise the reticulated structure

into monticular elevations or conuli; filaments respectively fixed to the shell by an expanded base and for the most part unbranched, that is ending by a *single* point, which may or may not project beyond the dermis; presenting the usual aplysinoid structure, and the whole about 3-24ths in. long. Pore-areas in the interstices of the dermal reticulation. Vents not seen. Flesh densely charged with the parasitic cell which I have named "*Palmella spongiarum*" ('Annals,' 1878, vol. ii. p. 165). Incrustation about 2-12ths in. thick, diminishing towards the circumference. Diameter of parasitic cell 1–1½-6000th in.

Loc. Port Phillip Heads.

Obs. This seems to me to be only a variety of my *A. nævus* (*l. c.*), in which the dermal sarcode is much less charged with foreign material than in *A. nævus.*

As it is almost entirely composed of the parasitic cell above mentioned, the soft structures of the body are almost as entirely obscured by it, which is the case also with one of the specimens of the calcareous sponge called *Teichonella prolifera*, to whose description I must refer the reader for a more detailed notice of it ('Annals,' 1886, vol. xviii. p. 147).

Aplysina cruor.

Massive, growing over the valve of a *Pecten*, supported on erect keratose filaments, based respectively on the shell and subdividing twice or thrice towards the surface into several short branches; covered by the usual soft fibro-reticulated dermis, which possesses an opaque *blood-red colour.* Colour produced by the presence of small oval, granuliferous cells, about 2½-6000ths in. in their longest diameter, filling the triangular spaces left by the juxtaposition of large, circular, nucleated, flat, epithelial cells, about 6-6000ths in. in diameter, which form a layer over the fibro-reticulated structure of the surface and from which the smaller pigmental cells are endogenously derived. Pores in the interstices of the dermal reticulation. Vents here and there. Internal structure consisting of fleshy sarcode supported on erect filaments of keratose fibre; filament expanded at the base, more or less branched, as above stated, about half an inch long. Size of specimen about 2 in. square and ½ in. thick.

Loc. Port Western.

Obs. The keratose filaments of this specimen also are remarkable for the presence of a minute branched filamentous alga, composed of concatenated cells, which appears to have entered by the base.

Pseudoceratida.

Pseudoceratina typica, n. sp. (dry).

Flabelliform, circular, thick, stipitate; stem cylindrical, expanding into a circular compressed head above and into a root-like disk of attachment below. Consistence now, in the dried state, crisp and wiry, from the hardened state of the keratose fibre. Colour clear amber-brown. Surface of dermal sarcode originally covered by a reticulated layer composed of white sand, being the originally soft, fleshy, reticulated structure charged with this material. Pores in the interstices of the reticulation. Vents scattered over the surface irregularly. Structure looking like that of the main fibre of a *Psammonematous* keratose skeleton overrun by one of a *Luffaria*; the latter, which is much smaller in diameter than the former and represents the so-called "secondary fibre," interuniting the psammoniferous branches, and present generally, to such a degree in the stem as to almost conceal the psammonematous part of the skeleton; hard, cylindrical, and, from desiccation, crisp now, presenting a transparent amber-colour, traversed continuously and uniformly by an opaque, white, homogeneous, cylindrical core, in short genuine *Luffarid* fibre. Size of specimen:—total length 9 in., of which the head is $5\frac{1}{2}$ high by $7\frac{1}{2} \times 1\frac{3}{4}$ in. horizontally; stem $3\frac{1}{2}$ in. long by $\frac{3}{4}$ in. in diameter in the middle, rather compressed.

Loc. Port Western.

Obs. This specimen is preeminently typical of the family Pseudoceratida, hence its designation. Nothing can be more marked or more distinct than the two kinds of fibre of which it is composed, viz. the Psammonematous and the Luffarid, each being genuine of its kind.

Before leaving the order CERATINA it may be as well to allude again to the comparatively large, more or less flat, circular or oval, nucleated, epithelial cells, with sharply-defined cell-wall, which form a layer over the soft, fleshy, fibro-reticulated, dermal structure that especially characterizes the surface of the *Aplysinæ*. Such cells I described and illustrated in two "Pachytragous" sponges from this place in 1871 ('Annals,' vol. vii. pp. 4 &c. pl. iv. figs. 6 and 14), viz. *Dercitus niger* and *Stelletta aspera*, pointing out that in the former they constitute a "cortical layer" of several cells deep in which they are held together by a soft fibro-reticulated structure or "sarcodal trama," that extends more or less into "the mouths

of the larger oscules" (*l. c.* p. 4); also that the same kind of cells are arranged "on the surface" of *Stelletta aspera* "in a tessellated manner" in "distinct cavities" of the same kind of sarcodal trama or fibrillous structure as in *Dercitus niger*, while such cells were not only to be found on the surface, but also "scattered throughout the sponge generally" (probably in connexion with the epithelial lining of the excretory canals), together with here and there a cell charged with black granules, also precisely like those of *Dercitus niger* (*ib.* p. 7). Thus it was observed that the material of the dark pigment was seated in the "granules" themselves, that is little cellulæ, although not always making itself visible.

Unfortunately a typographical error occurs here which causes the measurement of these cells to appear as "1-170th of an inch" in diameter, instead of 1-750th or 8-6000ths, which it ought to have been; thus they are a little larger than those of *Dendrilla rosea*, which, according to my measuring, vary under 6-6000ths, as will more particularly appear hereafter.

Schulze alludes to a layer of these cells in *Aplysina ærophoba* under the term "ectoderm" (Zeitschrift f. wiss. Zoologie, Bd. xxx. p. 392), and Lendenfeld does the same under the name of "Plattenepithel" in *Dendrilla rosea* (*ib.* Bd. xxxviii. p. 281, Taf. xii. fig. 19 E *c*), while Polèjaeff has given a representation of them in his *Cacospongia vesiculifera*, adding that they are "not dissimilar to the renowned and still debatable 'Schleimzellen' of Mollusca, as Dr. Fleming has drawn them, and thoroughly identical with the vesicular cells of many Desmacidonidæ undescribed hitherto, but undoubtedly very well known to every spongologist who has had to deal with the representatives of the family [Spongelidæ] just mentioned" ('Challenger' Reports, 1884, KERATOZOA, p. 59 of separate copy).

In some fragments of the soft, fibro-reticulated, dermal structure of a specimen of *Dendrilla rosea* which had fallen off from the skeleton during maceration, the circular cavities *alone* occupied by some of these cells remained, even after portions had been stained, dried, and mounted in balsam, so that it became perfectly evident that they had been imbedded in the fibre of the fibro-reticulated structure of the surface in *distinct* compartments similarly to those above mentioned which exist in a similar tissue in *Dercitus niger*; so that these epithelial cells do not always appear to be confined to a simple lamina.

I have already stated that their granules in *Dercitus niger* bear the black-brown colouring-matter of this sponge,

and that in *Aplysina cruor* they appear outside the cells, from which they seem to have been endogenously derived, in the form of minute granuliferous cellulæ about 1–2-6000ths in. in diameter, still bearing the red colouring-matter of this species. Moreover, in some instances, where somewhat enlarged, they present a nucleus surrounded by minute granules, and in this condition, losing for a time their pigmental character, seem to pass gradually into the largest form of the parents, the epithelial cells beside them; hence my allusion to these particulars where I have above stated that in *Dendrilla rosea* the size of the epithelial cell "varies under 6-6000ths of an inch." So that, by a repetition of this process, the epithelial cells and the pigmental granules are thus continually renewed.

That one function of the epithelial cell is to produce the colouring-matter there can be no doubt; neither can there be any doubt that it does not always perform this function, for in *Aplysina massa*, as above stated, there is with the same kind of epithelial cell no colouring-matter at all. Again, it is not uncommon to find the upper and more exposed portions of a sponge black (where this is the colour), while the lower and more shaded ones are colourless, ex. gr. *Spongia officinalis*, auctt. (see 'Annals' of 1882, vol. ix. p. 272), wherein also the black colour extends for a short distance into the external openings (oscules) of the large excretory canals.

It therefore may be possible (for Nature has always an unlimited number of resources) that they also possess the power of the "Schleimzellen" in Mollusca, as above noticed.

In some sponges, as in Mr. Wilson's Australian one, viz. *Axinella atropurpurea*, already described ('Annals,' 1885, vol. xvi. p. 359), such cells, bearing the colouring-granules, are dispersed generally throughout the mass, where I have before suggested they may still be connected with the lining membrane of excretory canals, although they do not present the flattened form of those on the surface; while in *Suberites Wilsoni*, the great carmine-coloured sponge of South Australia brought to my notice by Mr. Bracebridge Wilson, after whom I have named it, the colouring-matter appears to be diffuse, since I have never been able to find it in granules (*i. e.* the cellulæ of larger cells).

Lastly, I would observe that when the skin of an *Aplysina* and the like sponges is stript off the surface it is found to consist essentially of two layers, the outermost of which is composed of epithelial cells and their pigmental granules (if any) set in transparent sarcode, rendered more or less generally

cribriform by the presence of the "pores" (how far this sarcode may belong to the epithelial cells individually, and thus being agglomerated possess a general motory power like that of an Amœba or Myxogaster (*Æthalium*), I am not prepared to say),—and the innermost layer of a soft fibro-reticulated structure, in which the fibre is composed of fibrillæ in the form of elongated, linear, (?) muscular cells. The pores are best seen over the interstices of the fibro-reticulated layer, as the light then passes directly through them, when the reticulated fibro-framework of *their* structure again appears to be composed of the "transparent sarcode" in which the epithelial cells are imbedded, rendered more or less opaque here and there by the presence of an epithelial cell or two, with other granular matter.

[To be continued.]

XXIX.—*Contributions to the Study of the Littoral Fauna of the Anglo-Norman Islands (Jersey, Guernsey, Herm, and Sark).* By Dr. R. Kœhler.

[Plate XI.]

[Continued from p. 243.]

JERSEY (*continued*).

Crustacea.

The class Crustacea is represented at Jersey by numerous individuals belonging to various species. It was to the Crustacea, which interested me from various points of view, that I paid attention more particularly during my visits to the Anglo-Norman islands. I shall speak here only of the Decapoda, Isopoda, and Amphipoda. The number of species that I can record amounts to 141; and it is to be remarked that this is nearly the number indicated by Delage in the list given by him of the Crustacea of Roscoff, namely 119.

Decapoda.

Stenorhynchus phalangium, Edw., and *tenuirostris*, Bell, occur very commonly among the rocks. A third and more

interesting species, the existence of which was indicated to me by Mr. Sinel, is *Stenorhynchus ægyptius*, Edw., which, so far as I know, has not hitherto been seen out of the Mediterranean. This *Stenorhynchus* is only found about a small rock situated near the entrance of the port of St. Helier on the side of the Albert jetty, a rock which is uncovered only at spring-tides; moreover, it is not very abundant. Another type which is also very rare, namely *Achæus Cranchii*, Leach, is found frequently at the Havre des Pas, at the Crabière.

The three species of *Inachus* described by Bell occur at Jersey. *Inachus dorsettensis*, Leach, and *I. dorynchus*, Leach, are met with at various points of the southern coast of the island, but never in great abundance. *Inachus leptochirus*, Leach, has been several times captured by Mr. Sinel with the dredge in St. Aubin's Bay. Bell also regards it as a very rare species. *Pisa Gibbsii* and *tetraodon*, Leach, are common everywhere. The genus *Hyas*, allied to the preceding, is represented by two species, *H. coarctatus* and *araneus*, Leach, which are met with but rarely in the products of dredgings; they are found at a depth of 5–10 fathoms off Gorey. This is also the case with *Eurynome aspera*, Leach, which never quits a certain depth.

The species of *Xantho*, which are generally common enough on our coasts, are not very frequent at Jersey. *Xantho florida*, Leach, is not so scarce as *X. rivulosa*, Edw.

I will do no more than mention the following species, which are distributed everywhere in profusion:—*Pilumnus hirtellus*, Leach, *Cancer pagurus*, Bell, *Portunus puber*, Leach, *pusillus*, Leach, *arcuatus*, Leach, *Carcinus mœnas*, Leach, and *Pinnotheres pisum*, Leach. *Portunus corrugatus*, Leach, and *depurator*, Leach, are sometimes associated with them at La Mothe and La Rocque. *P. marmoreus*, Leach, has sometimes been found by Mr. Sinel; I have never met with it. *Portunus holsatus*, Fab., and *Portumnus variegatus*, Leach, are obtained only with the dredge. The latter is very rare, and I have never captured it.

I may cite further *Pirimela denticulata*, Leach, of which I have collected some specimens at low water at Fort Elizabeth, and with the dredge in St. Aubin's Bay; *Ebalia Bryerii* and *Pennantii*, Leach, which are obtained by the dredge in the same bay; and *Dromia vulgaris*, Edw., which does not live on the coast, but which the fishermen often bring up in the baskets (pots) employed in fishing for lobsters, and in which specimens of *Inachus* and *Stenorhynchus* and of *Portunus corrugatus* may also be collected. To conclude the enumeration of the Brachyura I may note *Porcellana platycheles*,

Lam., and *longirostris*, Edw., as very common; *Corystes cassivelaunus*, Penn., which lives buried in somewhat muddy sand and is found abundantly at Elizabeth Castle, where it digs galleries side by side with the Solens; and, lastly, *Thia polita*, Leach, which also lives in the sand and is tolerably common at La Rocque.

Of the Macrura I will first of all indicate *Gebia deltura*, Leach, *Callianassa subterranea*, Leach, and *Axius stirhynchus*, Leach, so as to continue the enumeration of the species which dig galleries in the sand. I have found all three of them at La Rocque in muddy sand, in which they bury themselves to a depth of several decimetres. The *Gebia* is not so common as the others. The *Axius* also sometimes occurs under stones at the Grève d'Azette.

I shall cite *Pagurus Bernhardus*, Forb., only as a matter of form. *Pagurus cuanensis* and *Hyndmanni*, Thomps., and *Eupagurus Prideauxii*, Leach, are frequently found in St. Aubin's Bay, but always with the dredge.

Palinuri and *Homari* abound, but their fishery is not very active. The genus *Galathea* includes *G. squamifera*, Leach, a very common species, and *G. strigosa*, Fab., of which I have collected several fine specimens at La Rocque. By dredging in St. Aubin's Bay I have obtained a third species, which, in a former memoir, I referred with doubt to *G. nexa*, Embl., pointing out the differences which distinguished it clearly from that species. This *Galathea* is *G. Andrewsii*, Norm.; moreover, Mr. Sinel has informed me that he had obtained by dredging a specimen of *G. nexa* agreeing with the type described by Embleton.

The group of the Caridina (*Salicoques*) is well represented by *Palæmon squilla*, Fab., and *serratus*, Fab., and by *Crangon vulgaris*, Fab., *fasciatus*, Risso, *bispinosus*, Westw., *trispinosus*, Hailst., and *sculptus*, Bell, which live in the pools of water or in the midst of the *Zosteræ*; the last three species are rare. *Nika edulis*, Risso, is not very frequent; *Pandalus annulicornis*, Leach, never quits the deep water and may be collected by the dredge; *Athanas nitescens*, Leach, is common under stones. *Hippolyte varians*, Leach, and *viridis*, Edw., abound in the meadows of *Zostera*; *Hippolyte Cranchii*, Leach, is less abundant; I have collected some specimens with the dredge.

Lastly, I will note *Lismata seticaudata*, Risso, of which one specimen was collected by Mr. Sinel in one of those baskets which the fishermen employ in the lobster-fishery. This species is regarded as peculiar to the Mediterranean.

The group of the Schizopoda is represented by numerous

examples of *Mysis chamæleon*, Thomps., a species which is exceedingly abundant among plants. *M. vulgaris*, Thomps., accompanies it here sometimes; but this is especially pelagic, as is also the case with *M. Griffithsiæ*, Bell. *Themisto brevispinosus*, Goods., is sometimes associated with *Mysis chamæleon*, but is not common. Mr. Sinel has also collected, with the preceding species, some rare examples of *Cynthia Flemingii*, Goods., and of *Thysanopoda Couchii*, Bell, species which for my own part I never met with.

The Stomatopoda are only represented by *Squilla Desmarestii*, Risso, which the fishermen sometimes bring in from the open sea.

Lastly, among the Cumaceæ I may cite *Gastrosaccus sanctus*, Ben., *Sphinoë serrata*, Norm., and *S. trispinosa*, Goods., which live among the *Zosteræ*, but are rare, and finally a small pelagic Cumacean, *Cuma Edwardsii*, Bell.

Isopoda.

The Tanaidina are not very abundant at Jersey. *Tanais vittatus*, Lillj., *Leptochelia Edwardsii*, Kröy., and *Paratanais forcipatus*, Lillj., live among the *Halichondria panicea* and *Cynthiæ* which clothe the surface of the rocks; *Anceus maxillaris*, Mont., and *Praniza cærulea*, Mont., are also found there. *Paranthura costata*, Spence Bate, and *Apseudes talpa*, Leach, are sometimes met with in similar situations.

The true Isopoda are more generally distributed. Belonging to the group of the *Idoteæ* we have *I. tricuspidata*, Desm., very common among sea-weeds, sometimes pelagic; *I. linearis*, Linn., generally distributed, usually associated with the preceding, but at certain points much more frequent, as, for example, at Elizabeth Castle; *I. acuminata*, Leach, of which I found a specimen at St. Aubin; *I. appendiculata*, Risso, not very abundant, which I have found at La Mothe; and, lastly, *I. emarginata*, Fab., which is always pelagic and lives in the midst of floating sea-weeds.

Among the Oniscidæ the best-known type is *Ligia oceanica*, Fab., which lives upon the rocks of the shore. The individuals are generally of very small size. *Janira maculosa*, Leach, is common under stones. Living among sponges and beneath the tufts of *Cynthia rustica* I have also met with *Janiræ* of smaller dimensions and of which the inferior antennæ are comparatively much shorter than in the typical *J. maculosa*. Delage also indicates a *Janira* with short antennæ at Roscoff. I do not think that we ought to ascribe any importance to this character, for among these small

Janiræ I find specimens whose antennæ scarcely attain half the total length of the body, while others have them nearly as long as the body. *Limnoria lignorum*, Rathke, which is found in floating pieces of wood, in which it hollows out galleries, is also placed among the Oniscidæ; I have collected at Jersey several specimens associated with an Amphipod, which is also xylophagous, namely *Chelura terebrans*, and with specimens of *Tanais vittatus*, accidentally present in the wood.

The family Sphæromidæ is represented at Jersey by *Sphæroma serratum*, Fab., which lives under stones, and *S. Prideauxianum*, Leach, which is frequently found among Algæ and Sponges; by *Cymodoce pilosa*, Leach, associated with the *Sphæromata*, but not common; by *Dynamene viridis*, Leach, and *D. Montagui*, Leach, and *Næsa bidentata*, Leach, moderately distributed throughout, very frequent in the empty shells of *Balani*. The species of these last two genera appear to adapt themselves with facility to different habitats; they occur sometimes in constantly wet gravels, sometimes upon rocks which are left bare every tide; lastly, I have collected several specimens by pelagic fishing.

Finally, to conclude this enumeration of the Isopoda Errantia, it remains for me to indicate *Cirolana Cranchii*, Leach, and *Conilera cylindracea*, Mont., species which do not live on the coast, but which the fishermen occasionally bring in from the open attached to their apparatus. The specimens of *Conilera* are not perfectly in agreement with the description of Spence Bate and Westwood, and appear to me to be identical with those noted by Delage at Roscoff, which differ from the type specimens "by the antennæ, by the natatorial appendages of the sixth abdominal segment, and by red punctuations, the absence of which is specified by the English authors." I possess *Conileræ* from Naples the characters of which agree absolutely with the description of the English authors, and from which the Jersey specimens differ by the following characters:—Length of the appendages of the last abdominal segment, length of the hairs borne by the fourth joint of the inferior antennæ, and lastly the presence upon the carapace of numerous small red spots.

Among the parasitic Isopods I can only cite *Bopyrus squillarum*, Lat., and *Anilocra mediterranea*, Leach.

Amphipoda.

The group Orchestiidæ has furnished me with *Talitrus locusta*, Lat., common on all the sandy beaches, *Orchestia*

mediterranea, Costa, which lives under stones, and *O. littorea*, Lat., pretty frequent among the Algæ. An allied type, *Nicea Lubbockiana*, Spence Bate, is met with pretty frequently under Algæ.

The numerous family of the Gammaridæ includes, in the first place, some *Montaguæ*, two species of which exist at Jersey, *M. monoculoides* and *marina*, Sp. Bate, the latter rather rare. They live in general under the tufts of *Cynthia rustica* and sponges which clothe the rocks. In the same stations *Anonyx Edwardsii*, Kröy., is found much more frequently. The specimens of this species present considerable differences in the length of the superior antennæ, which are sometimes shorter than, sometimes as long as the inferior antennæ; the flagellum presents analogous variations. *Ampelisca Gaimardii*, Kröy., is pretty often met with in pelagic fishing.

To the group Atylidæ belong:—*Dexamine spinosa*, Leach, a species common under the stones among vegetation (I may remark that in small individuals the characteristic tooth presented by the first joint of the superior antennæ generally does not exist), *Atylus Swammerdamii*, Sp. Bate, and *bispinosus*, Sp. Bate, *Pherusa bicuspis*, Edw., *P. fucicola*, Leach, and *Iphimedia obesa*, Rathke, species which are pretty common among vegetation, except *A. bispinosus* and *P. bicuspis*, which are scarcer.

The group Leucothoina is well represented by *Leucothoë articulosa*, Leach, which is associated among plants with the preceding species. *Aora gracilis*, Sp. Bate, also exists at Jersey; but I have found only a single specimen among tufts of *Cynthia*.

The Gammarinæ are very generally distributed. I will first of all note a *Gammarella*, of which I have found some specimens in the meadows of *Zostera*, and which differs from *G. brevicaudata*, to which it is nearly allied, by the length of its antennæ. I have already described this species under the name of *G. longicornis*. Then come *Melita palmata*, Leach, and *Mera grossimana*, Leach, two species pretty common among vegetation. *Erythræus erythrophthalmus*, Sp. Bate, *Gammarus marinus*, Leach, and *G. locusta*, Fab., are very frequent in the same stations. *Amathilla Sabini*, Leach, is scarcer. I will further indicate *Microdeutopus gryllotalpa*, Costa.

The group Podocerinæ is represented by numerous specimens of *Amphithoë littorina*, Sp. Bate, and a few of *A. gammaroides*, Sp. Bate, associated with the *Gammari*, *Atyli*, &c., and by *Podoceri*, two species of which, *P. capillatus*, Rathke, and *falcatus*, Sp. Bate, occur commonly under the *Cynthiæ*. *Siphonocœtes typicus*, Kröy., is met with sometimes among the

Algæ in the neighbourhood of Elizabeth Castle. I will mention further *Chelura terebrans*, which is associated with *Limnoria*.

The Læmodipoda are represented by *Protella phasma*, Sp. Bate, and *Caprella linearis*, Edw., two species very common among plants.

I must, lastly, cite, to complete the enumeration of the higher Crustacea, *Nebalia Geoffroyii*, Edw., common under stones which lie upon mud rich in organic detritus.

Insecta.

The number of marine insects at present known is very restricted. We hardly know more than *Æpus marinus* and *Robinii*, *Microlymma brevipenne*, and *Ochthebius Lejolisii*, which live on our coasts and really merit the name of marine insects. To these Coleoptera we must add the Hemipteron, *Æpophilus Bonnairei*, Sign., which was discovered only in 1879 at the island of Ré. It is an extremely rare species, and does not seem to have been met with again since that time; nevertheless there is a specimen in the British Museum bearing "Cornwall" as an indication of origin. I have been fortunate enough to find *Æpophilus* at Jersey, and I collected several examples of it, which have enabled me to study this interesting animal with care, and to rectify the incorrect interpretation which Signoret had given of the external genital organs. Moreover I have found the larva of this interesting Hemipteron, not in Jersey but in the caves of Gouliot, in the Isle of Sark.

In November 1885, Mr. Sinel also found in Jersey this same larva of *Æpophilus*, of which he has sent me some specimens.

Æpophilus Bonnairei (Pl. XI. figs. 6, 7) is 3 millim. in length, its breadth is 1·5 millim.; it colour is a rusty yellowish brown. The body, especially the abdomen, is covered with very fine and silky little hairs. According to Signoret the external genital organs are situated above the abdomen in the female and beneath it in the male. Now I easily convinced myself that this naturalist had mistaken the male for the female and *vice versâ*; in fact, I was able easily to recognize the presence of eggs in the individuals which he regards as males. Moreover, the mere inspection of the genital armatures enables one to recognize the sexes, for they correspond well with the classical description of the copulatory organs in the Hemiptera. I had not at my disposal a sufficient number of specimens to enable me to study the organs of copulation in detail, but the figures which I give of these organs in the

male and female are, I think, sufficient to give an idea of them (figs. 4 and 7).

Æpophilus Bonnairei occurs under strongly adherent stones situated at some depth among the gravels; it seems to remain there motionless, only to run with great rapidity as soon as the block which covers it is raised. I have found it in St. Clement's Bay, behind La Mothe, at points which are left bare every tide; it is associated with *Næsa bidentata, Gammarus marinus, Phascolosoma elongatum, Terebella conchilega, Cirratulus Lamarckii, Nereis cultrifera*, &c.

Æpus Robinii, Lab., also lives at the same station; during my first sojourn in Jersey I did not observe this beetle, but I found some specimens of it in 1885.

As to the larva of *Æpophilus*, it is a little smaller and more flattened than the perfect insect (fig. 2). It differs from the latter, in the first place, by the absence of genital organs and of elytra, and further by some peculiarities in the form of the rostrum and of the feet (figs. 5, 8, and 9).

In 1884 the existence of *Ochthebius Lejolisi*, Leach, at the Corbières, was indicated; it lives, with its larva, in the pools which are formed at low water near the bank. I looked for this insect in 1885, and likewise met with it.

There is nothing astonishing in seeing insects such as *Æpus* and *Æpophilus* living in regions of the coast which are uncovered at every tide. We know, in fact, that insects, even aerial insects, are able to resist a submersion lasting for several hours, or even one or two days, as appears from the interesting experiments of Plateau. Under these conditions the animal falls into a state of apparent death, but becomes reanimated when brought again into the open air, providing the duration of the submersion has not exceeded a certain limit.

But a thing that greatly surprised me was to find specimens of *Æpophilus* in the caves of Gouliot, in Sark, in the cave of the Tubularians, that is to say in a place which is only uncovered at the highest spring-tides. Now, if in the ordinary tides of the syzygies the sea retires sufficiently to lay bare the upper part of the caves, during the whole interval which separates two successive spring-tides the cave is absolutely full of water. We must therefore assume either that *Æpophilus* is able to live for several days together without being obliged to renew the provision of air which it retains in its tracheal system, or that it quits the caves to take shelter in a spot which is more frequently uncovered, and only reenters them at the time of the spring-tides; this latter hypothesis is hardly sustainable.

Among the other groups of Arthropods I may cite *Pycnogonum littorale*, Ström, and *Ammothea longipes*, Hodge, which are pretty common on the coast of Jersey among Algæ. I will also indicate a small mite, which is associated with *Æpus* and *Æpophilus*, and is perhaps a *Halacarus*.

GUERNSEY.

The island of Guernsey, situated to the north-west of Jersey, has the form of a right-angled triangle, of which the two sides of the right angle, corresponding to the eastern and southern coasts, are about 7 miles long, while the hypotenuse, which runs in a direction from south-west to north-east, is rather more than 9 miles in length. The east coast, the two extremities of which are St. Martin's Point in the south and Fort Doyle in the north, is slightly excavated, and nearly in its middle is situated the capital of the island, St. Pierre-du-Port.

The geological constitution of the island of Guernsey is very different from that of Jersey. The syenite, which in Jersey formed exposures of great extent, and which made its appearance at almost all points of the coast (except at the north-east and in St. Aubin's Bay), does not appear in Guernsey except in the northern region of the island, and is replaced in the south and south-east by gneisses associated with quartziferous porphyries, and by porphyrites, pegmatite, and some phyllades. Syenite appears especially in the north-eastern and western portions of the coast, and gives place in the north to considerable exposures of granite and diorite; important quarries are worked near St. Sampson and in the neighbourhood of L'Ancresse Bay.

It is to be remarked that in the regions where the coast is lowest, that is to say throughout nearly the whole western coast and the north-eastern half of the east coast as far as St. Pierre, we meet with diorite and syenite; but as soon as the coast begins to rise, that is to say on quitting St. Pierre, we see the gneisses and porphyries make their appearance and continue throughout the southern half of the east coast and the whole extent of the south coast of the island.

The part of the coast situated between St. Pierre and Fort Doyle is low, and the sea in retiring lays bare shores of considerable extent, interspersed with rocks. It is in this portion of the coast that is situated the port of St. Sampson, a small village of fishermen, connected with St. Pierre by a steam tramway; then, further to the north, the port of Bordeaux.

Between St. Pierre and St. Sampson the coast forms a very extensive but not deep bay, called Belgrave Bay. This bay, occupied partly by *Zosteræ* and partly by rocks clothed with sea-weeds, presents a tolerably varied fauna. The *Zosteræ* give shelter to some sponges (*Leucosolenia botrylloides* and *Isodictya fucorum*), small Crustacea (*Mysis*, *Themisto*, *Gastrosaccus*), Planariæ, compound Ascidia, and a few Nudibranchs (*Doris tuberculata*, *Eolis papillosa*). Under the rocks live some interesting species of sponges (*Halichondria incrustans*, *Oplitospongia papillata*, *Isodictya cinerea*, *Hymeniacidon mammeata*) and Polychæta. In Belgrave Bay I have also found at the limit of the lowest tides fine specimens of a *Leptoclinum*, the very thick corms of which are of a brilliant red colour, and which I refer to *L. Lacazii*, Giard.

Towards Bordeaux and over the whole portion which extends between that little port and the Homptol rock (below Fort Doyle) the coast is exceedingly interesting to explore, and it presents a fauna of great variety although in a rather restricted space. Certain regions are occupied by *Zosteræ* which shelter their usual fauna; other points present small sandy beaches traversed by rivulets, in which are found *Sagartia bellis* and *parasitica* and *Bunodes gemmacea*. Lastly, under the rocks and under stones incrusted with calcareous Algæ there live a number of not very common species. Sea-Urchins, *Comatulæ*, Ophiurans, and *Asterias glacialis* are abundant there. I have found several specimens of *Molgula socialis*, *Cynthia sulcatula*, *Ascidiella scabra*, *Clavelina lepadiformis*, *Chætopterus Quatrefagesii*, *Edwardsia callimorpha*, *Caryophyllia Smithii*, &c., and several calcareous sponges—*Grantia ensata*, *Sycon tessellatum*, *Leucosolenia lacunosa*, &c. This region of the coast, which extends to the north of Bordeaux, is certainly the one the exploration of which was most profitable to me.

The west coast of the island is likewise but little inclined; it is broken by several irregular bays, presenting at low water beaches of considerable extent sprinkled with rocks, which are not so high in the northern region, where they are composed of diorite, as in the south, where the diorite gives place to syenite. Among these bays the most important are L'Ancresse Bay, which looks towards the north, then the Grand Havre, and the bays of Pecqueriès, Cobo, Vazon, and Perelle, turned towards the north-west; it is beyond Cobo Bay that the syenite appears. Finally, Rocquaine Bay, the longest, which looks to the west, terminates this series of small gulfs; it extends from La Rée tower, opposite to which is the island of Lihou, to which one can go dryshod at low water, to

Pleinmont Point, which forms the south-western extremity of the island of Guernsey. I have explored this coast through nearly its whole extent except the little bays of Perelle and Pecqueriès.

L'Ancresse Bay is very poor, only presenting naked rocks, upon which is found *Actinia equina*, var. *fragacea*. It possesses no interest.

The Grand Havre is an interesting station as regards its fauna. The Algæ which cover the stones harbour many of the lower Crustacea (*Idotea tricuspidata* and *I. appendiculata*, *Atylus Swammerdamii*, *Podocerus falcatus*, *Anonyx Edwardsii*), together with *Galathea squamifera*, *Athanas nitescens*, *Stenorhynchus phalangium*, *Xantho florida*, &c. Among the Polychæta I found especially *Phyllodoce lamellosa*, *Eulalia clavigera*, *Glycera capitata*, *Eteone longa*, *Siphonostomum uncinatum*, &c. *Ascidia producta* and *Cynthia sulcatula* are common. The rocks are clothed with tufts of *Cynthia rustica*, under which the worms and Crustacea live. The sponges are tolerably varied—*Tethya lyncurium*, *Dictyocylindrus ramosus*, *Halichondria incrustans*, &c.

Cobo and Vazon Bays appear to me to be rather poor. The sand which occupies the bottom of them only contains a few not very interesting Annelides, and the rocks are covered with very common sponges (at least so far as I have determined them). At Cobo I found a specimen of *Chalina cervicornis*; but it had been thrown up by the sea. At Vazon Bay *Pholas dactylus* is pretty common. In this bay are found the remains of a submerged forest, from which the inhabitants formerly obtained a considerable quantity of combustible material; in the country they give the name of *corban* to these submerged remains.

The neighbourhood of the island of Lihou and Rocquaine Bay, on the other hand, present a tolerably rich fauna. The physiognomy of this region, both as regards the configuration of the coast and the aspect of the rocks at low water and as regards the fauna, is absolutely identical with that of the southern region of Jersey, for example at the Grève d'Azette. The sea forms numerous pools, of which the bottoms are carpeted with *Zosteræ*, and the rocks are covered with Algæ, among which swarm Crustacea, small Polychæta, and Compound Ascidia. Some species which are scarce or wanting in Jersey are met with at this station; the *Comatulæ*, for example, are very common there, as also *Glycera capitata*. I have also found some examples of *Cucumaria pentactes* and one of *C. frondosa*.

Starting from Pleinmont the coast rises rather suddenly and

soon presents perpendicular rocks, forming vertical cliffs overhanging the abyss and attaining a great height. Throughout its whole length to the Pointe St. Martin the south coast of Guernsey presents a series of picturesque bays and indentations separated by bold promontories. The perpendicular rocks forming these, being constantly beaten by the waves, are hollowed into numerous caves; gradually worn away at their base, they fall down in different parts and leave the deep indentations which irregularly cut into the coast. Thus on quitting Pleinmont Point and travelling eastwards we successively come upon the bays of the Creux-Mahié, Bon-Repos, La Moye, Petit-Bot, Icart, and Moulin-Huet, all places celebrated as very remarkable sites.

I have visited nearly all these bays at low water, and most of them had only to offer me naked rocks and an extremely poor fauna. The Moulin-Huet Bay alone forms an exception. The head of this little gulf presents rocks of pegmatite cut into sharp points and covered with Algæ, sponges, and Actiniæ, the whole somewhat reminding one of the fauna of the caves of Gouliot, in Sark, although much less rich than in the latter station. *Cynthia rustica*, *Halichondria panicea*, and *Hymeniacidon mammeata* are highly developed, and are associated with *Cynthia sulcatula*, *Molgula socialis*, *Leucosolenia lacunosa*, *Grantia compressa* and *G. ensata*, and *Sycon ciliatum* and *S. tessellatum*. *Actinia equina* is represented by numerous varieties; some examples of *Sagartia sphyrodeta*, Gosse, are also met with.

On passing the Pointe St. Martin the coast, which runs thence northward, is seen to become somewhat lower, although still remaining considerably elevated, except at the level of Fermain Bay. It falls rather suddenly at a short distance from the jetty which bounds the port of St. Pierre on the south. The fauna of Fermain Bay is rather poor; I met with hardly anything there except a few specimens of *Caryophyllia Smithii*, Stokes.

Sponges.

The Sponge-fauna is particularly rich on the coast of Guernsey. Besides *Sycon ciliatum*, which is common everywhere, I found at Moulin-Huet, at Bordeaux, and at Belgrave Bay specimens of *S. tessellatum*, Bow., a sponge which, according to Bowerbank, occurs only at the caves of Gouliot. *Grantia compressa* and *G. ensata* are also common at Bordeaux, where they are associated with *Leucosolenia lacunosa*. *Leucosolenia botrylloides* is common in all the meadows of

Zosteræ. I found at Guernsey all the sponges which I have indicated at Jersey, besides some forms, such as *Oplitospongia papillata*, Bow. (Belgrave Bay), *Chalina cervicornis*, Bow. (Cobo Bay), and *Isodictya densa*, *I. infundibuliformis*, and *Polymastia mammillaris*, Bow., which I met with in the produce of dredgings brought in by a fisherman.

Cœlenterata.

The Actiniæ are more numerous and more interesting at Guernsey than at Jersey. *Actinia equina* and *A. mesembryanthemum*, which are pretty common in the bays of the western coast, are less abundant in the north, and give place to less common types, such as *Aiptasia Couchii*, Gosse, which is found in abundance on days of spring-tide from St. Pierre to Fort Doyle. This species, so common in Guernsey, seems not to be very widely distributed; it is scarcely known except upon a few points of the coast of England (Falmouth). *Tealia crassicornis*, which is very abundant to the north of Bordeaux, attains a remarkable size, and is associated with *Sagartia bellis*, *S. troglodytes*, *S. parasitica*, and lastly *S. sphyrodeta*; the last-named, like the *Aiptasia*, is only observed in stations which are uncovered only at spring-tides. A variety of *Actinia equina*, *A. fragacea*, is extremely common in the bay of L'Ancresse and Moulin-Huet. From Bordeaux I have also procured fine specimens of *Edwardsia callimorpha*. Lastly, *Caryophyllia Smithii* seems to be pretty common at Bordeaux and in Fermain Bay.

The *Lucernariæ* which I foun l at Herm I have never met with in Guernsey.

Echinodermata.

These are much more abundant in Guernsey than in Jersey. The Common Sea-Urchin (*Strongylocentrotus lividus*), which is rare at Jersey, where it is never captured but with the dredge, is very abundant at Bordeaux, where it occurs in company with *Ophiothrix fragilis*, *Ophiocoma neglecta*, *Asteriscus verruculatus*, *Asterias glacialis*, and *Antedon rosaceus*. At the same station I have met with some specimens of *Cribrella oculata* and *Asterias rubens*. *Cucumaria pentactes*, Gum., also appears to be abundant to the north of Bordeaux; with it I have found two specimens of *Cucumaria frondosa*, Müll. The *Synaptæ* are very common and are found all round the island. On the west coast the Echinoderm fauna is less

varied. The *Comatulæ* are pretty generally distributed in Rocquaine Bay, where they are accompanied by *Asterias glacialis*, *Ophiothrix fragilis*, and *Asteriscus*. *Cucumaria pentactes* and *C. frondosa* also exist in Rocquaine Bay; but I have only found the Sea-Urchins in the north of the island.

One day I met with a small *Echinocardium cordatum*, Penn., in the neighbourhood of the Port, close to the Chateau Cornet; it is the only specimen of the species that I have found at the English islands. Lastly, in the produce of a dredging I observed fragments of *Luidia fragilissima*, Forbes. This interesting species seems to be tolerably abundant in the neighbourhood of Guernsey. A person who collects Actiniæ for the English aquaria showed me an entire specimen, which was found one day to the north of Bordeaux at low water. The fact deserves to be recorded, as the *Luidia* appears to be a rather rare form.

Vermes.

A list of the Vermes of Guernsey was published in 1866 by Ray Lankester in the Ann. & Mag. Nat. Hist. (vol. xvii. p. 388). I have found the greater part of the species indicated by that naturalist, at least of the Polychæta, but I have captured a certain number of forms which he does not record. Of the Turbellarians I have only met with a few species, which, moreover, also live at Jersey. I will indicate:—*Leptoplana tremellaris*, common everywhere; *Prostheceræus vittatus*, which lives in the *Zostera*-meadows (Belgrave Bay, Lihou; the Guernsey specimens are larger than those of Jersey); *Proceros argus*, Quatref. (Grand Havre); *Polycelis lævigatus* (Rocquaine Bay); and *Eurylepta cornuta* (Bordeaux, Grand Havre). *Lineus longissimus* is very common at Bordeaux; it is also met with at Cobo, at Lihou, and near the Port, under stones. *Nemertes gracilis* and *Tetrastemma candidum* also are not rare. The three Jersey species of *Valencia* are found in the mud covered with *Zosteræ*, where they are associated with *Marphysæ* and Clymenians.

The Polychæta are very abundant. The Amphinomians are represented by *Polynoë squamata*, *P. cirrata*, and *Sthenelais Edwardsii*, common at Bordeaux, Grand Havre, and Rocquaine Bay. Lankester also cites *Harmothoë sarniensis*, which I have not met with; as to *H. Malmgreni*, Lank., which, as is known, lives as a commensal in the tubes of the *Chætopteri*, I have found it also in Guernsey in the tubes of *Chætopteri* from the port of St. Pierre.

Among the Eunicians I may cite:—*Eunice Harassi*, abun-

dant everywhere; *Marphysa sanguinea*, from the muddy sands of Bordeaux and Rocquaine Bay; *Staurocephalus rubrovittatus*, Gr., found at Bordeaux under pebbles incrusted with calcareous Algæ; *Lumbriconereis contorta* and *L. humilis* and *Lysidice ninetta*, species which are also common in Jersey. Among the Nephthydians:—*Nephthys Hombergi* and *N. longisetosa*, the latter also living on the coast, and of which I found a specimen at Grand Havre. Among the Chloræmians:—*Siphonostomum uncinatum*, which is tolerably common, and *Chlorœma Dujardini*, Quatref., which occurs at Bordeaux in company with the Sea-Urchins. *Aonia foliacea* is sometimes met with in Rocquaine Bay.

I cite, only as a matter of form:—*Cirratulus Lamarckii*, *Nereis cultrifera* and *N. Dumerilii*, *Aricia Cuvieri*, and *Arenicola piscatorum* and *A. ecaudata*.

The Phyllodocians are represented by *Phyllodoce laminosa*, which is rather less common than *Eulalia clavigera*, and *Eteone longa*. I have found these three species at nearly all the points that I have explored. *Glycera capitata* is exceedingly common; *G. lapidum* is sometimes associated with it.

Among the Syllidians I will cite:—*Syllis amica* and *S. divaricata*, and *Grubea fusifera*, besides a number of small species identical with those of Jersey and which have not been determined.

Two species of *Chætopterus* live in Guernsey, namely *Chætopterus Valencinii*, Quatref., and *C. Quatrefagesii*, Jourd. The former is very common in the port of St. Pierre itself, in the portion included between the old port and the jetty which bounds the new port on the north. This species, which possesses a U-shaped tube, is identical with that of Herm. Ray Lankester, who does not indicate *Chætopterus* at Guernsey, calls the animal from Herm *C. pergamentaceus*, Cuv. It is not easy to determine whether *C. pergamentaceus* and *C. Valencinii* are two identical forms; but the specimens from the port of St. Pierre and those of Herm present all the characters of *C. Valencinii* indicated by Quatrefages. The anterior region presents sometimes eleven, sometimes twelve segments. In the tube of this *Chætopterus*, in half the specimens, *Harmothoë Malmgreni* lives as a commensal; one never finds more than a single specimen at a time.

The second Guernsey species of *Chætopterus* which I have found at Bordeaux is identical with that indicated at Jersey, *C. Quatrefagesii*, the differential characters of which have been clearly established by Jourdain. Its tube is never bent into a U, but it is simply attached to the lower surface of a stone; it resembles a large Terebellan tube. Its structure is

the same as that of the tube of *C. Valencinii*, but it is much thinner. The animal is smaller than in the latter species, and the anterior region of its body presents only nine segments.

Clymene lumbricoides accompanies the *Marphysæ* in the muddy sands. At Bordeaux I found *Petaloproctus terricola* enclosed in a tube with very thick walls, formed of agglutinated fine sand, and fixed to the lower surface of stones.

The fauna of the Terebellians and Serpulians differs little from that of Jersey. *Terebella conchilega* and *T. nebulosa* are common at Bordeaux, at the Grand Havre, and on the western coast of the island, where *T. prudens* is also met with. North of Bordeaux I have also found a specimen, unfortunately in very bad condition, of a *Terebella*, which I refer to *T. Montagui*, Quatref. (*T. cirrata*, Mont.), indicated by Lankester at Guernsey. *Protula protensa* is also common in Rocquaine Bay. *Sabella arenilega* and *S. verticillata* are common; *S. pavonina* is rather rare, and I have met with only two specimens of it at the Grand Havre. With *Spirorbis communis* and *Vermilia conigera* and *tricuspis* I may cite further *Serpula fascicularis*, which is abundant at Bordeaux.

As at Jersey, the Gephyrians are represented by *Phascolosoma elongatum* and *P. margaritaceum*.

ASCIDIA.

The fauna of the simple Ascidia seems to be rather less developed at Guernsey than at Jersey. At Guernsey I have not found *Cynthia granulata*, *Ascidiella aspersa*, *Molgula roscovita*, and *Ctenicella Lanceplaini* of Jersey. The other Ascidia are those of Jersey. *Molgula socialis*, Ald., is pretty common at Bordeaux; I have also found it at Moulin-Huet, but always of small size in the latter locality.

The Compound Ascidia, which are not common at Bordeaux and in the north of the island, are more abundant at Lihou and in Rocquaine Bay, where the genera *Amaroucium*, *Fragarium*, *Morchellium*, *Leptoclinum*, *Botryllus*, and *Botrylloides* are represented by varied species. I will also record *Leptoclinum Lacazii*, which I have indicated above in Belgrave Bay.

CRUSTACEA.

A certain number of species captured at Jersey I have not met with at Guernsey, such as:—*Stenorhynchus ægyptius*, *Portunus pusillus*, *Thia polita*, *Galathea strigosa*, *Inachus dorsettensis*, *Crangon sculptus*, *C. bispinosus*, *C. trispinosus*, *Mysis*

Griffithsiæ, and all the types which I captured with the dredge at Jersey. Certain forms of Decapods, such as *Pirimela denticulata*, *Xantho florida*, and *X. rivulosa*, are common at Guernsey. But in general the fauna of the higher Crustacea is not very rich, especially in the north of the island. *Scyllarus arctus*, Rœm., is frequently brought in by the fishermen, who dredge it off the island.

As regards the Isopoda and Amphipoda, they are absolutely identical with those of Jersey. Certain species, such as *Paranthura Costana*, *Apseudes talpa*, *Tanais vittatus*, and *Leptochelia Edwardsii*, are commoner at the Grand Havre and in Belgrave and Rocquaine Bays than at Jersey.

Mollusca.

A considerable number of species recorded by M. Duprey at Jersey have not been met with by me at Guernsey. But the results obtained by a few weeks of researches must not be compared with those obtained by M. Duprey by a long investigation. In the list of animals which concludes this memoir I have indicated some species which he did not find at Jersey and which I have met with in Guernsey in the north of the island.

As in Jersey, the Nudibranchs are represented by *Doris flammea*, Ald., *D. tuberculata*, A. & H., *D. Johnstoni*, A. & H., *Eolis Cuvieri*, Lam., *Triopa claviger*, Müll., and *Pleurobranchus membranaceus*, Mont., species which are all common enough in the *Zostera*-meadows.

In the north of the island of Guernsey there are two pools of brackish water, one situated near the church of Vale, in a private property, the other to the west of the Grand Havre, near the road which skirts the west side of that bay and leads towards the Pointe Rousse. Near St. Sampson, in the neighbourhood of the old castle of Vale, there is also a small stream of brackish water, in which we find only *Palæmon varians*, Leach. But the fauna of the two pools is more interesting.

The pool at Vale is in free communication with the sea, which is able to enter it at all tides. The species which ordinarily live in fresh water are not numerous; they are larvæ of *Chironomus* and some *Pisidia*. The marine types are represented by *Mysis chamæleon*, *Idotea tricuspidata*, *Melita palmata*, *Corophium longicorne*, Lat., *Gammarus locusta* and *G. marinus*, *Sphæroma serratum*, and *Rissoa*

labiosa. Palæmon varians and *Philhydrus maritimus*, Solier, are very abundant. Near the bank freshwater plants, *Scirpi* and rushes, are very vigorous, and accommodate themselves very well to an existence in the brackish water.

The pool situated to the west of the Grand Havre is less extensive than the preceding; the sea-water penetrates into it by infiltration. I have found numerous larvæ of Diptera belonging to at least four different species, as well as the larvæ of a Hemipteron belonging to the genus *Corixa*, associated with *Philhydrus. Melita palmata* and *Jæra Nordmanni* are very abundant, as well as *Gammari*. In the mud which occurs near the margins I have found several specimens of *Nereis falsa*, Quatref.

[To be continued.]

XXX.—*Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland).*—No. VI. *On the very young Cod and other Food-Fishes.* By Prof. M'Intosh, M.D., LL.D., F.R.S., &c.*

It is about twenty years (viz. 20th May, 1866) since Prof. G. O. Sars found the larval cod 6–7 millim.† in length on the surface of a sea teeming with ova off Loffoden; yet up to this time there is no account of a connected series between the larval fish as it issues from the ovum and the larger forms mentioned by Sars and other authors. It is true Sars gives various links in the chain:—Thus, on the 12th June, 1866, he again observed the young cod at the surface, the largest reaching 24 millim. in length, and he considers they had attained this size in the interval (three weeks). Their embryonic fin-fold has now become divided into first and second dorsals, and a small barbel is present. On the 5th July he procured others an inch and a half in length under Medusæ. His observations were continued in the following year, for on the 3rd August he met with young cod two inches and upwards, and on the 23rd of the same month nearly three inches in length. In the beginning of October again they were upwards of four

* Communicated by the Author, having been read at the Birmingham Meeting of the British Association (Biological Section), Sept. 1886.

† This is larger than recently-hatched cod in this country.

inches long. In November of the following year he caught some about six inches long, and larger forms in December. In the early part of the next year (probably the end of February) the young cod had reached a foot in length. He therefore concluded that he had a fairly connected series under review, and accordingly summarizes as follows:—When the young cod are hatched in April and May the yolk-sac keeps them floating on the surface of the water, tossed about by wind and waves. After absorption of the yolk-sac they begin to lead a more independent life, though not strong enough to resist the currents. Towards the end of summer they are about an inch in length and come nearer the shore, in company with Medusæ or in the lines of floating sea-weeds. They, as a rule, keep near the bottom. Those seen towards the end of February about a foot in length are thus a year old. Finally, as they get older they go out to sea.

It is remarkable that no zoologist has repeated these interesting and valuable observations. The obstacles are, however, considerable, the chief being the difficulty of finding the fishes on the same or neighbouring ground at the various stages, or proving the continuity in age of the respective groups on different grounds; and, secondly, the absence of due appliances in ships and boats in this country. However, thanks mainly to the enlightened exertions of Lord Dalhousie, we shall by-and-by be in a position to afford further information on this and other food-fishes.

In the trawling experiments of 1884 the young cod were found in vast numbers near the surface of the sea on the great banks frequented by the adult fishes, such as Smith Bank, off the coast of Caithness, and the rich ground south-east of the Island of May. These little cod (a few millim. in length) are easily recognized by the peculiar arrangement of the black pigment-specks *; indeed there is no larval fish known to me which at present can be confounded with them. This statement, however, is not of much moment, since it must be stated that no larval fish with which we are at present acquainted can be confounded with another, so definite are the characters of the pigment and other parts after a brief period of freedom. On the east coast of Scotland the young cod escape from the ova during the month of April, sometimes a little earlier, sometimes a little later, according to the nature of the winter. In the laboratory they could seldom be kept

* These are well seen when the fishes are placed in sea-water in a white porcelain vessel, and they have been carefully drawn by Mr. E. E. Prince.

alive longer than a month, when they attained the length of about 5 or 6 millim., though it is probable growth is somewhat slower in confinement than in freedom. It is clear at any rate that a fish which is hatched devoid of a mouth and circulation in April, and only a few millim. in length, cannot (so far as present observations lend support) grow to any considerable size or attain great complexity of organization that season.

At sea the forms a little older than those seen in the laboratory have generally escaped us, only a specimen or two half an inch long having been captured in the tow-net; yet certain parts of the sea in May and June must abound with the early stages of the cod. Of the later stages in every variety there is no lack. Early in June, or, in some years, in July, young cod appear off the rocks at St. Andrews in shoals, their length varying from $1\frac{1}{8}$ in. to $1\frac{3}{4}$ in. A month later they have attained $1\frac{3}{8}$ to $2\frac{1}{2}$ in. They accompany the green cod into the rock-pools, rich in tangles and other seaweeds, and which have a communication with the sea. They feed there on the multitudes of larval crustaceans and Copepoda, and shelter themselves under the blades of the seaweeds when hunted. They are easily recognized by the reddish colour of the occiput and gills; and their coloration (diced), large heads, lean bodies, and slower motion distinguish them from their associates, the young green cod, many of which show a very distinct barbel on the chin, though it is small in the adult. They go on growing as Sars indicates and as mentioned in the 'Trawling Report.'

To be brief, the main point of this note is the age of these young cod which appear off St. Andrews rocks in June and July. The spawning-season on the east coast of Scotland (as ascertained both by examination and dissection of the adults and capture of the eggs and embryos) is tolerably uniform, and thus a fixed date is given for the reckoning. According to Prof. Sars these would appear to be the young of the season, and which next February would be a foot in length. So far, however, as the growth of other fishes can afford a means for comparison and judgment, it seems doubtful if so rapid a growth can take place between April and June. The condition of the vertebral column, skeleton in general, and the structure of the otoliths (*sagitta* and *asteriscus*) in the smallest of those which appeared this year on the 7th June seem to me to point to their being the young of the previous season, if the observations on the spawning-period are correct, and indeed this would require to be much antedated to fall in with the condition of the young cod as

observed in June. That a tiny embryo (a few millim. in length) in April should in June and July have reached so large a size, and with organs so complex, seems at variance with what is known of the growth of other Teleosteans—for example, of the salmon, catfish, ling, gurnard, skulpin, and the Pleuronectidæ. Even the catfish, which in its adult state is nearly the size of the cod, and which deposits its large ova (of the size of a salmon's) at the end of the year, does not attain such proportions at this period (June) in confinement, and though feeding freely. Mr. R. E. Earll also observes * that in America the young cod $1\frac{1}{2}$ to 3 inches in length in June had been spawned the previous December. Couch mentions his meeting with young cod less (that is a little less) than an inch in May, a size which could hardly apply to those hatched in March or April. Whether the cod spawns earlier in certain regions has not been clearly determined, and, at any rate, the present remarks apply to the east coast of Scotland. Further, the spawning-period this year on the east coast was late, yet the young cod of the size above mentioned appeared in the Laminarian region and rock-pools earlier than last year.

Moreover, the results of the use of the large triangular townet † in deep water on board the fishery tender 'Garland' within the last few days corroborate the foregoing view. Quite a new field has been opened up by the use of this net in the foregoing ship and in the yawl 'Dalhousie,' attached to the laboratory, in the shallower water of St. Andrews Bay—a field, indeed, which presents us with novelties of no ordinary interest in regard to the remarkable condition of some of the larval organs, *e. g.* the fins, an instance of which is seen in the very long ochre-coloured ventrals of the young ling ‡. Again, a complete series of young gurnards from the egg up to the adult form has been obtained—the majority of the smaller forms by a single sweep of the net off the island of May; and no young fish is more beautiful as well as more remarkable than a young gurnard about $\frac{3}{4}$ inch in length, for its enormous pectorals are edged with white and finely

* U. S. Fish Com. Rep. 1878.

† This net is made of fine though strong gauze, is fully 20 feet in length, and is fixed to a triangle composed of three wooden beams, each 10 feet long. The latter are hinged so that they can be folded together in transit. The apparatus is sunk to the required depth by a heavy leaden sinker, and kept uniformly there by means of a line and a galvanized iron float, such as is used for the ends of herring-nets. The most active young fishes do not readily escape this net as they do an ordinary tow-net.

‡ This may be (somewhat fancifully) termed the Pterichthyid stage of such fishes.

banded with crescents of pigment (as in the *Trigla lineata* of authors), which likewise forms striking touches here and there on its body. The three free filaments of the pectorals are united by a membrane nearly to the tip, and are used by the fish when creeping on the bottom. The condition of the very young haddock, skulpin, frogfish, ling, rockling, and young flatfishes of various kinds in August (and of this season), all bear out the opinion above expressed, viz. that the young cod which appear off our rocks (and ranging in length from $1\frac{1}{8}$ to $1\frac{3}{4}$ inch in the beginning of June) are not the product of the eggs which abound near the surface of the sea chiefly in April.

In reference to Prof. Sars's remark about the association of the young fishes with Medusæ, I may observe that this association in the earlier stages with the Ctenophora is followed by different results, for occasionally, on examining the contents of the large midwater-net, many *Pleurobranchiæ* have young fishes in their stomachs. These young fishes, it is true, are either dead or sickly; but *Pleurobrachia* is capable of engulfing somewhat active forms, such as Zoeæ. Whether the products of the reproductive organs of the Medusæ are utilized by the larval fishes is still an open question. Their enormous numbers in the sea around them, at all events, is a striking feature. Hydroids, such as *Obelia geniculata*, are greedily eaten by young green cod, and the stomachs of the adult common cod contain diverse Cœlenterates.

XXXI.—*Histological Investigations upon the Nervous System of the Chætopoda.* By Dr. Emil Rohde *.

Histological investigations upon the nervous system of *Polynoë elegans* had shown me that the so-called neural canals in the Polychæta were colossal nerve-fibres, the detailed study of which promised important data as to the structure of the nervous system in animals generally. By the munificence of the Berlin Academy of Sciences I was last year enabled to work for several months in the Zoological Station at Naples, and to collect from the Polychæta occurring in the Bay abundant materials for the further prosecution of this

* Translated by W. S. Dallas, F.L.S., from the 'Sitzungsberichte der k. preussischen Academie der Wissenschaften,' July 29, 1886, pp. 781-786.

inquiry. I may be permitted here to express to the Academy my thanks for its kind assistance.

In what follows I give in outline the results I obtained with regard to the nervous system in the family of the Aphroditeæ, of which I have studied, in accordance with the newest methods of investigation, the genera *Aphrodite*, *Hermione*, *Sthenelais*, *Sigalion*, *and Polynoë*. I will not here enter upon a discussion and criticism of the literature of the subject, but will refer the reader to a larger memoir upon the same subject which will very shortly appear.

For the understanding of the colossal nerve-fibres it is necessary to preface a word or two upon the so-called Leydigian dotted substance (*Punktsubstanz*). If the brain of the Polychæta be examined in thin sections, it is seen to consist of very numerous fine fibrils, which are confusedly intermixed and appear sometimes as lines in longitudinal sections, sometimes as points in transverse sections. The ventral cord has essentially the same structure, only in this longitudinal fibrils predominate, which, however, are crossed by oblique and transverse ones. In contradistinction to the brain, transverse and longitudinal sections in the ventral cord show a different picture—the longitudinal sections more lines, the transverse sections more dots. The nerves emitted are exactly of the same structure as the ventral cord, only in them the longitudinal course of the fibrils appears still more clearly, although even here straight and oblique ones are not excluded. The ventral cord, therefore, is not a central organ of peculiar structure, but only a somewhat more strongly-developed nerve which is beset with ganglion-cells. Even in those Aphroditeæ in which the ganglion-cells do not form a uniform coat of the ventral cord, but at definite distances apart constitute so-called ganglion-nodes, as in *Hermione* and *Aphrodite*, these ganglion-nodes are only distinguished histologically from the commissures lying between them and the emitted nerves by the processes of the ganglion-cells which traverse the central fibrils transversely. Anastomoses between the individual fibrils, by which a union of the ganglion-cells would be established, I have been unable to observe, any more than a breaking up of the fibrils into granules.

In this mass of fine fibrils the colossal nerve-fibres appear distinctly. They are the processes of colossal ganglion-cells, which occur in the brain and ventral cord in definite relative positions. The genus *Sthenelais* is a very favourable object for the study of the colossal nerve-fibres, as in it they are particularly numerous and highly developed. In *Sthenelais* there are three kinds of them, namely:—1, traversing the

whole nervous system from front to back; 2, running from behind forwards; and 3, starting in each segment on each side from the nervous system and running to the periphery.

If we trace the nervous system of *Sthenelais* in cross sections from before backwards we find even in the posterior part of the brain a colossal ganglion-cell on each side, which sends its large process first of all forward for some distance into the brain, and then through the œsophageal commissures into the ventral cord. Here the two nerve-fibres, after a short course, unite into a single one, which runs ventrally on one side of the ventral cord to the posterior extremity of the body. This colossal nerve-fibre is enveloped by a fibrous sheath, which is at first closely applied to it, but in its further course separates from it and then encloses a cavity, which constantly becomes larger posteriorly and in the middle of the body attains an enormous diameter. In this region also the nerve-fibre, which almost disappears in its wide sheath, becomes essentially modified; it shows everywhere on its surface denticulations of different sizes, which frequently pass into fine processes, traversing the whole cavity and apparently penetrating into the sheath. Towards the posterior extremity of the body the cavity becomes smaller, until the nerve-fibre again almost completely fills the sheath, and thus conditions corresponding to those of the anterior extremity are re-established.

At the commencement of the ventral cord on each side there are associated with this colossal nerve-fibre five others of exactly the same structure. Soon after the union of the œsophageal commissures with the ventral cord there are on each side two colossal ganglion-cells placed ventrally, the processes of which penetrate into the nervous system and pass over to the other side to run backward, closely applied to the median partition-wall which here divides the ventral cord into two. Almost at the same time two lateral colossal ganglion-cells on each side send their nervous processes transversely through the ventral cord towards the opposite side, where they run almost exactly in the middle to the end of the body. Close behind these ganglion-cells a fifth finally occurs on each side, the process of which does not pass to the opposite side, but bends in the longitudinal direction immediately after its entrance into the ventral cord.

But, as already indicated, colossal nerve-fibres traverse the whole ventral cord, running not only from before backwards, but also in the opposite direction.

Thus at the commencement of every body-segment, except only about the anterior sixteen, there is placed laterally, but

always only upon one side of the segment—to the left in one, to the right in another, but without any definite order—a colossal ganglion-cell, the strong process of which passes to the opposite side, but returns to its original side after a short course, here quitting the nervous system dorsally and running forward applied against the dorsal surface of the ventral cord. The first of these lateral ganglion-cells occurs in the antepenultimate body-segment. In about fourteen of the following segments anteriorly the number of the dorsally-placed colossal nerve-fibres constantly increases by the ganglion-cell processes which join them in the individual segments, until six or seven of these nerve-fibres run on each side. This number does not increase further, although in each segment a colossal ganglion-cell contributes its process. I have been unable to ascertain with certainty whether in the middle segments of the body on the accession of a new nerve-fibre some of the old ones unite together or come to an end. Sometimes one sees some neighbouring nerve-spaces run together; but I have not observed any union of the true nerve-fibres situated in them. On the other hand, I several times saw some of the dorsal nerve-fibres quit their places and enter into the nervous system, where, after a time, they disappeared.

Besides the lateral ganglion-cells just described there is on each side, in the middle of each segment, a ventral colossal ganglion-cell the process of which traverses the ventral cord, issuing from it on the other side, and running in the subcuticula towards the surface of the body. In these colossal nerve-fibres running peripherally there is no development of a cavity within the sheath.

By means of transverse sections I have been able to trace out the mode of termination of the colossal fibres in those running from before backwards. In the last segments the sheath becomes gradually thinner, and the nerve-fibres, which are closely embraced by it, more and more distinctly granulated. Finally the sheath ceases entirely. After a short course the nerve-fibre also disappears without becoming perceptibly thinner. In its place in the cross section we see fine points with no definite arrangement. The colossal nerve-fibre has consequently broken up into fine fibrils.

In *Sigalion* there are only colossal nerve-fibres running from before backward, and, indeed, in each half of the ventral cord a median one and a ventral one, of which the former is the process of a ganglion-cell situated in the initial portion of the ventral cord; while the ventral fibre, in accordance with the conditions in *Sthenelais*, owes its origin to a ganglion-cell occurring at the end of the brain.

In *Polynoë* two median nerve-fibres and one ventral on each side traverse the ventral cord from before backward. The first two distinctly unite with ganglion-cells in the beginning of the ventral cord; in the case of the ventral fibre, which appears even in the œsophageal commissures, I have not succeeded in ascertaining the ganglion-cell belonging to it.

In agreement with *Sthenelais* there is, moreover, in *Polynoë* in each segment on each side an enormously large ganglion-cell, which sends its colossal nervous process transversely through the ventral cord into the last of the three nerves starting in each segment, in common with which it runs to the periphery.

In *Aphrodite* and *Hermione* colossal nerve-fibres of such construction are entirely wanting.

In conclusion, I will say a few words as to the structure of the ganglion-cells and their relation to the central fibrillar mass of the nervous system.

The ganglion-cells of the Aphroditeæ are without exception unipolar. In the rest of their structure, however, they show an extraordinary variety. Two opposite types especially occur among them. The ganglion-cells of one kind are very faintly granulated and therefore of clear appearance, and generally rather small. Their nucleus always contains several corpuscles of different sizes, and, when stained, is exceedingly prominent in the transparent ganglion-cell. They have a pyriform shape and lie, in large packets, close together. The representatives of the second type are very large spherical structures, which immediately catch the eye by their very dark granulation. They possess a large finely-granulated nucleus, and this a single large corpuscle. They are always single, never united into groups. To this type also belong the colossal ganglion-cells. Both kinds of ganglion-cells are destitute of a cell-membrane and lie imbedded in a network of fibres, which everywhere accompany the nervous system and, I believe, originate from subcuticular cells. But while this envelope of subcuticular fibres is very slight in the ganglion-cells of the first type, appearing rather as a thin partition between the closely appressed cells, in the second type, and especially in the colossal ganglion-cells, it is highly developed.

The processes of the transparent ganglion-cells of the first type run in bundles and interlaced with each other into the nervous system, accompanied by subcuticular fibres, which, however, disappear soon after their entrance. These cell-processes, which are generally very delicate, gradually become

thinner and pass over directly into the central fibrils. The processes of the ganglion-cells of the second type are broad dark fibres, upon which the sheath extends its cells for a long distance. They can therefore be easily traced in the nervous system among the fine fibrils, especially as their breadth does not diminish. After running some distance they lose their sheath and soon afterwards disappear in the mass of fine fibrils. It seems to me most probable that, like the colossal nerve-fibres, which they greatly resemble, they pass into the fibrillar substance by brush-like division, as I could never observe any binary division.

If we examine the ganglion-cells of the second type, and especially the colossal ones, we find that the whole cell is traversed in all directions by fibrils of different strengths, which pass over into the cell-process and give it a fine longitudinal striation. But these fibrils do not quit the cells only in this way; one is astonished to see how they issue everywhere at the periphery of the naked cell-body, singly or united into bundles, and penetrate into the subcuticular envelope. This observation may be made uniformly in preparations hardened in alcohol or in corrosive sublimate or osmic acid. Whether the ganglion-cells are united to one another by means of these fibrils I have been unable to decide, as they were not to be traced beyond the envelope of subcuticular fibres.

XXXII.—*An Entomogenous Fungus.* By William Fawcett, B.Sc., F.L.S.

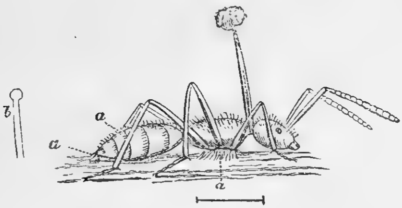
Dr. Günther has received from Mr. C. A. Lloyd, George Town, Demerara, a remarkable fungus growing on an ant (*Camponotus atriceps*). Mr. Lloyd found it on the banks of the river Puruni, in British Guiana, and though he has collected numerous specimens of different species of ants, he has not hitherto met with a similar growth. It is not so usual to find them on a perfect insect as on larvæ. Of the 47 species noted by Saccardo *, 23 (or about 50 per cent.) are found on larvæ, and only 16 (or about 33 per cent.) on perfect insects. Of these 16 species Saccardo only mentions 3 as having been found on ants—*Cordyceps unilateralis* on *Atta cephalota* in Brazil, *C. australis* on *Pachycondyla striata* in Brazil, and *C. myrmecophila* on *Myrmica rufa* (also rarely on an ichneu-

* 'Sylloge Fungorum,' vol. ii.

mon and a beetle) in North America, Europe (including England), Ceylon, and Borneo.

In the British Museum collection *Cordyceps unilateralis* also occurs on *Camponotus atriceps* from Brazil, and on *Echinopla melanarctos* and *Polyrhachis merops*, both collected by Mr. A. R. Wallace at Tondano, a village in the island of Celebes; *Formica sexguttata*, from Brazil, is also attacked by a fungus, too incomplete for identification.

Two species of *Cordyceps* are reported to have been found on species of *Coccus*, namely *C. pistillariæformis*, in England and North America, and *C. coccigena*, in New Guinea. The latter was partially described by Tulasne * from an immature specimen. The figure which he gives bears a great resemblance to Mr. Lloyd's fungus, and it is possible that it may be the same species.



Cordyceps Lloydii. *a*, mycelium; *b*, apex of ascus.

The ant has the appearance of having been attacked by the fungus while it was alive. The growth of the fine threads of the mycelium through the body would gradually exhaust it, until at last they have grown out at the joints of the thorax and abdomen, and attached it to the leaf on which it was standing, while the capitate stroma has then grown up between the head and thorax.

The following is a description of the fungus:—

Cordyceps Lloydii, nov. sp.

Stromatibus solitariis, pallide ochroleucis, ex articulo cervicali enatis; *capitulum* perithecigerum depresso-globosum, altitudine circ. 0·7 mill., latitudine circ. 1·5 mill.; *stipite* filiformi, infra medium autem incrassata, longitudine 4·5 mill., crassitudine ad basim apicemque 0·25 mill., infra medium 0·5 mill.; *peritheciis* stromate immersis protracto-ovatis; *ascis* longissimis, cylindraceis,

* Fung. Carp. iii. p. 19, tab. i. fig. 10.

apice glandiformibus, circiter 160 μ, aparaphysatis; *sporidiis* filiformibus, asci longitudine, hyalinis, immaturis.

Hab. in corpore formicæ atræ (*Camponotus atriceps*), prope flumen Puruni in Guiana (*C. A. Lloyd*).

A long filament also springs from between the thorax and the abdomen, ending in an acute apex.

XXXIII.—*Description of a new Species of* Sphenophorus (*Coleoptera, Calandridæ*). By CHARLES O. WATERHOUSE.

Sphenophorus Cumingii, n. sp.

Elliptico-ovalis, convexus, niger, nitidus; maculis sordide albis notatus.

Long. 7 lin.

A little shorter than *S. piceus*, with the elytra decidedly more convex; the thorax and tarsi quite differently formed. Rostrum rather stout, shining, with a deep elongate fovea at the base. The antennæ as in *S. piceus*. Thorax as long as the width at the base, slightly constricted in the middle, widest at the posterior angles, which are a little prominent. The surface is dull, except the front part of the disk; the punctuation fine and moderately close, except in front, where the punctures are larger. There is a yellowish-white spot at the anterior angle, one in the middle in front (placed in a slight depression), one on each side of the disk, and three at the base. Scutellum small and narrow. Elytra broadest just below the shoulders, very slightly constricted about the middle; shining, except a rather broad, dull velvety band across the middle and at the apex; punctate-striate, the punctures in the striæ elongate, very distinct; the interstices flat, very delicately punctured on the disk, strongly punctured at the base and apex. Each elytron has seven small yellowish-white spots—one near the scutellum; another below the shoulder; three rather behind the middle on the third, fifth, and eighth interstices; and two at the apex. Pygidium convex, obtusely rounded at the apex, dull, the punctuation rather fine. Underside with several white spots. The anterior coxæ more separated than in *S. piceus*, with two slight swellings behind them. Tarsi with the first and second joints narrow, the third large, equilaterally triangular, with the angles rounded.

Hab. Philippine Islands (*H. Cuming*).

BIBLIOGRAPHICAL NOTICES.

Catalogue of the Birds of Suffolk; with an Introduction and Remarks on their Distribution. By Churchill Babington, D.D., V.P.R.S.I., F.L.S., &c. London: John Van Voorst, 1884–86.

Amongst the workers in the vast field of Natural History there are none who confer a greater public benefit than those who undertake the task of working up local lists, and no one who has not had to refer to these lists for working purposes can realize their extreme utility; and Mr. Babington, to whom we are indebted for the present Catalogue of the Birds of Suffolk, has executed the task he has undertaken conscientiously and well. This Catalogue is a reprint of a series of articles issued in the 'Proceedings of the Royal Suffolk Institute of Archæology and Natural History' in 1884–86, together with sundry additions and corrections, and in its present form constitutes an important addition to the many local lists that have been published on the ornithology of Great Britain.

Mr. Babington has collected from all possible sources what available information is to be had respecting the avifauna of the county, and has most carefully sifted the evidence respecting the occurrences of the rarer stragglers. It is to be regretted that the author has elected, in dividing the county into districts, to make use of the hundreds, instead of making natural divisions such as are referred to in the earlier pages of his chapter on the distribution of the birds, inasmuch as these latter divisions would be readily comprehensible to any ornithologist, whereas but few will be any the wiser respecting the general distribution of the birds even after a careful study of the map of the hundreds which is issued as a frontispiece.

It is much to be deplored that several species which formerly used to breed regularly, if not commonly, have now become rare and have entirely ceased to nest in their old haunts. Thus the Marsh-Harrier is now said to be "apparently the rarest of the Harriers in Suffolk," and the Hobby, though stated to "breed in several districts," does not appear to have been found nesting in the county for some years past. The Spoonbill and the Black Tern have been driven away owing to their breeding-places having been invaded; and even the Black-headed Gull, which formerly bred on a mere at Brandon, has forsaken its old haunts in consequence of the plundering of its nests. It is satisfactory, however, to find that, in consequence of the Act of Parliament for the Preservation of Wild Birds, "the song-birds and several other species, for example the Ducks, Gulls, and Plovers, have recently increased in numbers in Suffolk," and that the Bearded Titmouse "is still (1886) found in some numbers at Oulton Broad."

Seven photographs of rare birds are issued with the work, two of which (plates v. and vi.) are of the immature bird supposed to be referable to *Cygnus buccinator*, a species which has been included

as doubtful in the British list; and it would be well if this specimen, which is now in the Ipswich Museum, were carefully compared with examples of the Mute and Trumpeter Swans, so as to set the question finally at rest.

On the whole we confidently recommend Mr. Babington's Catalogue to all who take an interest in British birds.

Birds on the British List, their title to enrolment considered, especially with reference to the British Ornithological Union's List of British Birds, with a few Remarks on Evolution and Notes upon the rarer Eggs. By the Rev. Gregory Smart, M.A., late Scholar of Trinity College, Cambridge. London: R. H. Porter, 1886.

Several Lists of British Birds have been published during the last few years, each one, to a large extent at least, filling up a void space in our ornithological literature; but we must confess that we fail to discover in what way the present List tends to supply any want in that direction. It appears to be a mere random collection of many of the doubtful species included in the British Ornithologists' (not Ornithological, as above stated) Union's List, together with many not referred to in that List, and which most undoubtedly never have been met with in the British Isles, some of which (as, for instance, *Mimus polyglottus*, *Lanius excubitoroides*, *Archibuteo sancti-johannis*, *Podilymbus podiceps*, &c.) appear to be included merely to afford an opportunity of describing their eggs in the author's collection. Judging, indeed, from the notes given by the author, we can only conclude that he is a mere egg-collector, with but little knowledge of ornithology or experience in natural history, as in many cases he appears to have got hopelessly befogged. For instance, he says (p. 41) that if the eggs of *Anthus ludovicianus* in his collection be authentic, "*Anthus ludovicianus* and *Anthus campestris* can scarcely be conspecific," a statement which he could never have made had he any acquaintance with these so totally distinct species. Again (p. 42), he quotes under *Anthus cervinus* a note by Mr. Robert Gray (not Grey) on *Anthus ludovicianus*, as if these two species were identical; and further to complicate matters, he remarks that, as "these birds have not been preserved, and Professor Newton is inclined to assign them to *rupestris*, it will depend on Grey's (*sic*) capability of distinguishing between the two forms"—thus inferring that Gray is doubtful of the distinctions between *Anthus rupestris* and *A. cervinus*. Both forms of Spotted Eagle are included in the List as British, whereas it would appear that only one (*Aquila clanga*) has really been proved to have occurred in Great Britain; and at p. 9, under his note on *Aquila clanga*, he describes the eggs of that species as having been taken in Pomerania, a locality where only *Aquila pomarina*, and not *Aquila clanga*, is known to nest.

Under the notes on *Acanthyllis* (*Chatura*) *caudacuta*, after stating

that its eggs are unknown, he proceeds to describe the eggs of a widely different Nearctic species, the Spine-tailed Swift, and remarks that he has "reason to believe that eggs of this species are passed off by some dealers for those of the Needle-tailed Swift" (*A. caudacuta*)—a statement which, if correct, merely tends to show how very easily mere egg-collectors are imposed on by unscrupulous dealers.

No care appears to have been exercised in selecting the proper scientific names, either generic or specific, in accordance with the generally accepted rules of synonymy; and one finds therefore the Killdeer Plover rejoicing in the generic title of *Oxyechus*, the Spotted Sandpiper in that of *Tringoides*, and the Solitary Sandpiper in that of *Rhyacophilus*, whereas, on the other hand, both the Yellow-legged Sandpiper and the Bar-tailed Godwit are classed under *Totanus*.

At pp. 91 and 92 lists are given of the doubtful species which the author considers should be admitted in or excluded from the British List; and here we fail to see, judging from the evidence on record, why *Buteo lineatus*, *Coracias leucocephalus*, *Colaptes auratus*, *Charadrius virginicus* (*dominicus*), *Podilymbus podiceps*, &c. should be admitted, and *Emberiza pusilla*, *Emberiza melanocephala*, *Motacilla viridis*, &c. excluded.

Many other comments and criticisms occur to us as we glance through the pages of this List, but we think that it will be useless to weary our readers with further remarks.

At the end of the List (pp. 97–148) "a few remarks on evolution" are given, and (pp. 150, 151) a "compendious scheme of Reconciliation between the Earth's Record compiled in the Nineteenth Century and the Divine Record delivered to Moses" is given in tabular form; and here, again, we can offer no further comment than that we think it would have been better both for the author and his readers had he studied the subject a little more closely and digested the vast amount of available material before committing his ideas to paper.

MISCELLANEOUS.

On a new Parasitic and Nidulant Rhabdocœlan (Fecampia erythrocephala). By M. A. Giard.

The curious Turbellarian which forms the subject of this note is very common on the shores of Fécamp and Yport. During a part of its existence it lives parasitically in Decapod Crustacea of various species—*Carcinus mœnas*, *Platycarcinus pagurus*, and *Pagurus Bernhardus*. *Carcinus mœnas* is the most commonly infested, but only when it is young; to find the parasite we must open crabs from $\frac{1}{5}$ to $\frac{4}{5}$ inch broad. The grey or blackish colour of the carapace reveals almost with certainty the presence of the *Fecampia*.

The parasite is lodged in the general cavity beneath the digestive tube and partly concealed by the liver; it is often folded back upon itself in the form of a U, with the convexity turned towards the posterior margin of the carapace. Sometimes we find two or three parasites in the same crab. In an edible crab 1 inch broad I found eight *Fecampiæ*; several were concealed in the liver, others had even penetrated into the muscles of the legs. In *Pagurus* the parasite takes up its abode in the abdomen in the midst of the liver, and it is sometimes visible from without through the skin.

When extracted from its host and in an extended state the *Fecampia* may attain a length of $\frac{3}{5}$ to $\frac{4}{5}$ inch. It is a worm with a cylindrical body, attenuated towards the anterior extremity, which is of a fine crimson colour, contrasting strongly with the general colour of the body, snowy white with a faint rosy tint. Two narrow, transparent, lateral lines start from the posterior extremity and ascend to about one third of the length of the body. These lines correspond to the ovarian glands.

The integument is formed by an exoderm of flat, polygonal, vibratile cells, without bacilli, among which open numerous very voluminous cutaneous glands, the function of which will be stated further on. The musculature is formed by annular and longitudinal fibres. These muscles give the body peristaltic movements resembling those of the Nemertians; the muscular layer is, however, very weak, and on the least pressure the contents of the animal flow with the greatest facility.

The buccal aperture is anterior; it leads into a not very distinct pharynx, which is followed by a rudimentary digestive tube.

The nervous system consists of two supraœsophageal ganglia, united by a commissure and giving origin on each side to two lateral nerves of considerable size.

The whole mass of the body is composed of the generative organs; the smallest rupture of the integument permits the escape of large cylindrical or irregularly ovoid cells, filled with clear vesicles and active corpuscles, which I regard as forming part of the testis. It is to these elements that the snowy aspect of the parasite is due. The ovary is formed by very distinct cellular elements, and is accompanied by a voluminous deutoplasmigene, the cells of which have a rosy colour, due to very regular granulations; the genital aperture is situated at the posterior extremity of the body.

On arriving at sexual maturity the *Fecampia* quits its host and proceeds to crawl freely over the stones in the small pools which the sea leaves full of water when it retires, and in which corallines and *Chætomorpha aerea* grow in abundance. The *Fecampia* does not keep its back upwards, but usually crawls upon one side with the head slightly raised, and describes spirals, like a caterpillar which is spinning its cocoon. In fact, our parasite soon surrounds itself with a thick coat of threads secreted by the cutaneous glands, and producing a regular case, which in form resembles a Prince-Rupert's drop. This cocoon is white, formed by a web, which is rather loose externally, denser towards the body of the animal; its

substance becomes brittle by coagulating in sea-water. It communicates by a narrow neck with the circumambient medium.

When we have once witnessed the formation of these singular cocoons it is not difficult to find them on the lower surface of stones, where they are generally sheltered in the hollows, and often hidden in the midst of the tubes of *Spirorbes*, *Vermiliæ*, &c.

On opening a cocoon with fine needles we find within it the parasite surrounded by its eggs. The latter are rose-coloured, held together by a gelatinous substance, and lining the inner surface of the posterior part of the cocoon. The *Fecampia* has lost a considerable part of its bulk; the slender anterior part has become much longer and thinner; the body is more rounded and of a reddish colour; the snowy whiteness has vanished, no doubt in consequence of the expulsion of the male products. It is towards the end of August that the *Fecampiæ* begin to undergo this transformation; it is also at this period that the females of *Carcinus mœnas* begin to carry their eggs. The young larvæ of *Fecampia* must therefore be developed in parallelism to the Zoeæ and Megalopi, and infest one or other of them. The eggs have a thin transparent wall and the characters of summer eggs. The segmentation is holoblastic and regular.

I hope soon to complete these observations by the description of the larva. It remains to be seen what becomes of the parasite when oviposition is terminated and it has completed the incubation of the eggs. But it seems to me that the facts indicated in this note deserved being brought without delay under the notice of naturalists.

From the preceding it will be seen that *Fecampia* differs considerably from *Graffilla* and the various genera of parasitic Rhabdocœla previously described. It appears to approach a parasite discovered by Lang in the foot of *Tethys fimbriata*, and I am persuaded that a more complete investigation of that Mediterranean type will show that it also secretes a cocoon.

In conclusion, I will recall the fact that an American naturalist, Charles Girard, many years ago noted in a Planarian (*Planocera elliptica*) a motionless and opaque form which he called a *chrysalis*, and which, perhaps, is not without analogy with the state observed by us in *Fecampia*. In *Planocera*, however, the encystation takes place during the larval period and has nothing to do with the incubation of the eggs.—*Comptes Rendus*, September 13, 1886, p. 499.

Observations on the Pollinization of the Indigenous Orchideæ. By M. Paul Maury.

Referring to a recent paper by M. Léon Guignard on the pollinization of some exotic Orchids, the author states that he has made observations upon the following native species:—*Neottia ovata*, *nidus-avis*; *Orchis fusca*, *simia*, *morio*, *mascula*, *maculata*, *latifolia*, *laxiflora*; *Loroglossum hircinum*; *Ophrys arachnites*, *myodes*, *apifera*; *Platanthera bifolia*; *Cephalanthera grandiflora*; and *Epipactis atrorubens*.

In most of the above species the ovules are very slowly developed, and their development is far from being completed when the flower begins to wither, which is generally eight or ten days after its opening. Hence in each flower the pollinic masses attain their complete development long before the ovules, and may be destroyed or carried away by insects, wind, or rain, without the ovules of the flower being fertilized. But in the same inflorescence there are flowers in all stages of evolution; the lowest or oldest ones may therefore be fecundated by the pollen of the higher or younger ones. This is what usually takes place; the ovaries at the bottom of the inflorescence alone arrive at maturity.

The ovary of the Orchids remains open in many species. The upper part of its orifice, at the base of what is usually called the stigma, is simply closed by tumefied or even liquefied epidermic cells, forming the nectar, situated between the stigma and the base of the labella. When the pollinic mass falls or is conveyed upon this mucilage it is at once broken up into tetrads, and each grain of the tetrad begins to germinate.

The pollen germinates thus for a certain time:—two or three days in *Neottia ovata* and *Platanthera bifolia*, five or six days in *Orchis latifolia*, seven or eight days in most of the other species, and about nine or ten days in *Loroglossum hircinum* and *Ophrys*. When the pollen-tube reaches the nucule the latter projects considerably beyond the integument; but when the contact has taken place the ovule is rapidly developed and soon acquires its definitive demensions.

In our Orchideæ the vegetation is comparatively short (about six weeks for the *Neottia*, six weeks or two months for most of the species, and three or four months for *Loroglossum hircinum*), and the ovule takes twenty days or more for its complete formation, that is to become fit for fecundation. The seed ripens in a much shorter time.

The pollen-tube does not reach the ovule through the tissues of the stigma or the carpels. The ovary is gaping, and through its orifice the pollen-tubes pass united into a bundle, agglutinated by a mucilage produced by the jellying of the superficial cells of the carpellar walls. This modification of the cells is caused by the advance of the pollen-tube, and does not take place in ovaries which have not been fecundated.—*Comptes Rendus*, August 2, 1886, p. 357.

Manual of North-American Birds.

We have received from Messrs. J. B. Lippincott & Co., of New York, a notice that they are about to publish a 'Manual of North-American Birds' from the pen of Prof. Robert Ridgway, whose contributions to the literature of North-American ornithology are well known. Prof. Ridgway's knowledge of the habits of birds in a state of nature, and his connexion with the Ornithological Department of the National Museum at Washington, will doubtless enable him to make this a valuable contribution to the literature of ornithology. The work will be abundantly illustrated, the estimated number of figures being 425.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 107. NOVEMBER 1886.

XXXIV.—*Preliminary Report on the Monaxonida collected by H.M.S. 'Challenger'**. By STUART O. RIDLEY, M.A., F.L.S., of the British Museum, and ARTHUR DENDY, B.Sc., Associate of the Owens College, Manchester.

PART I.

THE following brief descriptions of genera and species are published by kind permission of Dr. John Murray, F.R.S.E., Director of the 'Challenger' Commission. We propose to describe in this place none but the new species, and those only very briefly. The classification adopted is a modification of those already in use, which seems to meet the requirements of the case.

Order MONAXONIDA.

Siliceous sponges with uniaxial skeleton-spicules.

Suborder I. HALICHONDRINA (Vosmaer).

Typically non-corticate; skeleton usually reticulate. Skeleton-spicules usually acerate or acuate.

* For figures we must refer the reader to our forthcoming Report.

Family 1. **Homorrhaphidæ** *.

Skeleton-spicules acerate to cylindrical; no flesh-spicules.

Subfamily i. *Renierina.*

Spicules never completely enveloped in horny fibre.

Genus Halichondria (Fleming).

Skeleton confused; spicules acerate, long and slender; little spongin.

Halichondria solida, n. sp.

Massive, incrusting. Greyish yellow. Compact, firm. No special dermal skeleton. Skeleton a confused dense mass of felted acerates; no fibres. Spicules smooth, curved, fusiform acerates blunted at the ends; length up to 1·1 millim., thickness up to 038 millim.

Localities. Reefs, Tahiti, 30–70 fath.; Api, New Hebrides, 60–70 fath. (var. *rugosa*).

Halichondria pelliculata, n. sp.

Erect, lobose, annulated. Vents at summits of lobes. Yellow. Surface glabrous, covered by a chitinous membrane. Soft internally. Dermal reticulation composed of scattered acerates. Main skeleton sparse, with few distinct fibres. Spicules stout fusiform acerates, curved, sharp-pointed; size ·45 by ·028 millim.

Locality. Amboyna, 100 fath.

Halichondria latrunculioides, n. sp.

Erect, lobose. Light grey. Soft and spongy internally. Surface corrugated but glabrous; with rounded pore-areas elevated above the rest. Dermal membrane parchment-like, except in the pore-areas, where it is very thin and reduced to a sieve by the numerous pores. Vents singly on conical processes, chiefly at summit of sponge. Dermal skeleton a continuous sheet of spicules laid side by side. Main skeleton loose, irregularly fibrous. Spicules almost straight, fusiform acerates sharp-pointed, size ·7 by ·022 millim.; also a larger form, with unequal ends, size 1·25 by ·031 millim.

Locality. Station 320, off Rio de la Plata, 600 fath.

Genus Petrosia (Vosmaer).

Texture firm to stony. Vents conspicuous. Skeleton

* ὁμὸς, one and the same; ῥαφὶς, needle.

confused, but with broad compact tracts of spicules. Spicules acerate to cylindrical, commonly short and stout.

Petrosia similis, n. sp.

Repent, branched, or erect, lobose. Vents large, on upper surface. Yellowish grey. Texture more or less firm, fibrous. Surface smooth. Dermal membrane distinct, supported on ends of primary fibres. Skeleton, of primary and secondary fibres forming rectangular meshes. Spicules slightly curved acerates, fairly sharp; size ·225 by ·016 millim.

Localities. Stations 142 and 150, Southern Ocean, 150 fath.; Station 314, off Falkland Islands, 70 fath. (var. *massa*); Station 208, Philippine Islands, 18 fath. (var. *compacta*).

Petrosia truncata, n. sp.

Massive, sessile. Yellowish. Hard and stony, but rather brittle. Surface smooth. Only one vent present in the single specimen, $\frac{1}{6}$ inch in diameter, at the summit of a large tubular projection. Skeleton a reticulation of stout spiculo-fibre, primary and secondary fibres distinct. Fibre compact, about ·1 millim. thick. Spicules short, stout, slightly curved, cylindrical; size ·17 by ·0094 millim.

Locality. Station 208, Philippine Islands, 18 fath.

Petrosia hispida, n. sp.

Massive, sessile, lobate, narrowing at base; with numerous small papillæ, each bearing a single small vent. Yellowish grey. Fairly compact, rather brittle. Surface uneven, minutely hispid. Skeleton a reticulation of spiculo-fibre, in which the primary lines are fairly distinct, but the secondary very confused and almost obliterated by numerous scattered spicules. Spicules slightly curved acerates, not very sharply but rather gradually pointed; size ·37 by ·021 millim.

Locality. Royal Sound, Kerguelen, 25 fath.

Genus Reniera (Nardo).

Skeleton composed of definite rectangular (sometimes triangular or polygonal) typically unispicular meshes. Spicules short acerates or blunted acerates.

Reniera subglobosa, n. sp.

Sessile, subglobular, hollow, thick-walled, with a wide circular opening at the summit. Diameter about 1 inch. Yellowish grey. Texture firm but very brittle, cavernous.

Main skeleton a confused but subrectangular reticulation of loose fibre two or three spicules wide. Also a unispicular dermal reticulation. Spicules slightly curved, subhastately and sharply pointed acerates; size ·3 by ·013 millim.

Locality. Station 307, south-west coast of Patagonia, 147 fath.

Reniera tufa, n. sp.

Massive, sessile, cake-like. Greyish yellow. Texture firm, almost stony, but brittle. Surface smooth but uneven. Dermal membrane readily peeling off. Vents rather small, circular, level with surface. Skeleton a compact but rather irregular, almost unispicular reticulation with triangular meshes. Spicules slightly curved, subhastately pointed acerates; size ·2 by ·01 millim.

Locality. St. Jago, Cape Verds, 100–128 fath.

Subfamily ii. *CHALININA.*

A considerable amount of spongin present, typically forming a thick sheath around the fibres.

The classification of the Chalinina is at present in a very unsatisfactory condition. We hope to learn much from Dr. v. Lendenfeld's forthcoming descriptions of his Australian species, and must acknowledge our indebtedness to him for allowing us to examine his specimens, a few of which are identical with species here described.

Genus PACHYCHALINA (Schmidt).

Lobose or digitate, solid, with even surface. Fibres stout, with spicules numerous, arranged polyserially.

Pachychalina megalorrhaphis, n. sp.

Long cylindrical branches up to ½ inch thick. Pale yellow. Compressible and elastic. Surface nearly smooth. Dermal membrane thin. Vents small, subuniserially arranged. Skeleton :—(*a*) dermal, not very distinct, small-meshed, loose-fibred, echinated at nodes by ends of primaries; (*b*) main, a subrectangular reticulation of spiculo-fibre and scattered spicules, primary lines distinct. Fibres strong; no distinct sheath of spongin. Spicules slightly curved, gradually sharp-pointed acerates; size ·25 by ·016 millim.

Locality. Station 163 D, off New South Wales, 120 fath.

Pachychalina elongata, n. sp.

Digitate, ramose; branches long, diameter about $\frac{1}{3}$ inch. Compressible and elastic, tough and fibrous. Dermal membrane with its supporting skeleton-reticulation forming a tough skin. Vents small, scattered, chiefly on one side. Skeleton:—(*a*) dermal, close-meshed, fibre echinated by projecting spicules; (*b*) main, a rectangularly meshed reticulation of spiculo-fibre. Fibre ·07 millim. thick, with much spongin, spicules not confined to centre. Spicules slightly curved acerates; size ·1 by ·0065 millim.

Locality. Station 162, Bass Straits, 38 fath.

Pachychalina (?) *punctata*, n. sp.

Erect, flattened, lobate; thickness about $\frac{1}{4}$ inch. Dark greyish yellow. Tough and leathery, compressible and elastic. Surface uneven but glabrous. Vents minute, on one side only. Pores unusually large, visible to the naked eye as minute openings abundantly scattered on both sides, lined by spongin, which projects into the cavity in large bosses, frequently giving it a cruciform outline *. Skeleton:—(*a*) dermal, close-meshed; fibre echinated by projecting spicules: (*b*) main, primary fibres ·07 millim. thick, vertical to surface, crossed by secondaries; fibres polyspiculous, but with a thick sheath of spongin; numerous spicules occur scattered between the fibres. Spicules sharp-pointed acerates; size ·09 by ·0055 millim.

Locality. Station 162, Bass Straits, 38 fath.

Pachychalina (?) *pedunculata*, n. sp.

Erect, stipitate, cylindrical, stalk short. Height $5\frac{1}{2}$ inches; diameter of body $\frac{3}{4}$ inch, of stalk $\frac{1}{4}$ inch. Greyish yellow. Soft and spongy, elastic. Very minutely hispid. Dermal membrane thin and delicate. Vents small, scattered. Skeleton of loose fibres and scattered spicules; main fibres alone distinct; no special dermal skeleton. Spongin scanty. Spicules rather slender, slightly curved, gradually sharp-pointed acerates; size ·5 by ·017 millim.

Locality. Kerguelen Island, 10–100 fath.

Genus Dasychalina †, n. g.

Solid, coarsely spined on surface; skeleton-fibres stout, spicules polyserial; amount of spongin variable, never very great.

* These projections doubtless serve to prevent the entrance of small animals.

† δασὺς, rough.

Dasychalina fragilis, n. sp.

Irregularly ramose, subcylindrical, aculeated. Branches about $\frac{3}{4}$ inch in diameter. Light greyish or brownish yellow. Texture hard and brittle. Vents large and scattered, chiefly on one side. Skeleton:—(*a*) dermal, an irregular network of spiculo-fibre and spicules, backed behind by a coarse reticulation of stout fibre: (*b*) main, an irregular reticulation of very stout, compact fibre and scattered spicules; fibre about ·35 millim. thick. No distinct sheath of spongin. Spicules acerate, large, slightly curved, abruptly and rather bluntly pointed; size ·42 by ·02 millim.

Locality. Station 208, Philippine Islands, 18 fath.

Dasychalina melior, n. sp.

Irregularly ramose, subcylindrical or subangular, coarsely aculeated, but not so much so as *D. fragilis.* Diameter of branches about $\frac{1}{2}$ inch. Greyish or brownish yellow. Rather hard, compressible, fibrous. Vents small and shallow, chiefly on one side. Skeleton:—(*a*) dermal, a close-meshed reticulation of loose spiculo-fibre, echinated at nodes by bundles of spicules: (*b*) main, a rather irregular reticulation of spiculo-fibre and scattered spicules; fibre much slenderer than in *D. fragilis,* but no distinct sheath of spongin. Spicules rather slender, slightly curved, gradually sharp-pointed acerates; size ·175 by ·0126 millim.

Locality. Station 208, Philippine Islands, 18 fath.

Dasychalina fibrosa, n. sp.

Branched, coarsely spined. Vents large and circular, mainly on one side. Branch $\frac{1}{4}$ to 1 inch thick. Greyish yellow. Coarsely fibrous, elastic. Skeleton:—(*a*) dermal, a coarse reticulation of stout spiculo-fibre, meshes triangular, broken up by a much finer reticulation of very slender spiculo-fibre; (*b*) main, of stout, branching, and anastomosing spiculo-fibre, up to ·14 millim. thick, and scattered spicules. Spongin very abundant in the finer dermal fibres. Spicules small slender acerates, abruptly pointed, often blunted; size ·1 by ·0032 millim.

Localities. Off Bahia, 7–20 fath.; Station 208, Philippine Islands, 18 fath.

Genus Chalina (Grant).

Form various, not tubular, smooth. Skeleton reticulation

rectangular, with much spongin and a few spicules; fibre, typically thin, with a single axial series of spicules.

Chalina rectangularis, n. sp.

Incrusting, thin, with low mound-like prominences, each bearing a vent. Pale yellow. Texture compact but compressible and elastic. Surface subglabrous. Vents small. Skeleton:—(*a*) dermal, a polygonally, small-meshed reticulation of spiculo-fibre, polyspiculous, with little spongin, echinated by tufts of spicules; (*b*) main, a very regular rectangular reticulation of strong polyspiculous spiculo-fibre, with much spongin completely enveloping it, thickness ·06 millim. Spicules short, stout, abruptly sharp-pointed acerates; size ·088 by ·009 millim.

Locality. Station 208, Philippine Islands, 18 fath.

Genus SIPHONOCHALINA (Schmidt).

Tubular. Tubes smooth inside and out, usually narrow, each with a round oscular opening at summit.

Siphonochalina intermedia *, n. sp.

Bushily ramose; branches stout, short, sometimes anastomosing. Greyish yellow. Soft and spongy, but tough and fibrous. Surface glabrous. Skeleton:—(*a*) main, a regular rectangular network of spiculo-fibre; fibre rather slender, with much spongin, cored by polygonally arranged spicules; thickness of fibre about ·032 millim.; also scattered spicules: (*b*) dermal, a very delicate reticulation of spiculo-fibre, with much spongin and uniserially arranged spicules. Spicules slender acerates, rather abruptly pointed, up to ·1 millim. long and ·006 thick.

Locality. Port Jackson, 7–8 fath.

Siphonochalina annulata *, n. sp.

Rooted, stipitate, ramose. Branches long, distinctly annulated, often anastomosing; stem short and slender. Soft and spongy, but tough and fibrous. Surface glabrous. Skeleton:—(*a*) dermal, a reticulation of rather stout spiculo-fibre with much spongin, echinated by tufts of spicules; (*b*) main, a feebly developed subrectangular reticulation of spiculo-fibre, ·07 millim. thick, cored by polyserial spicules. Spicules subfusiform acerates, sharply and rather gradually pointed; size ·1 by ·0065 millim.

Locality. Station 162, Bass Straits, 38 fath.

* Specific name given by Dr. v. Lendenfeld in MS. Catalogue.

Family 2. **Heterorrhaphidæ** *.

Spicules of various forms; flesh-spicules commonly present, but never anchorates.

Subfamily i. *Phlœodictyina* (Carter).

Sponge divisible into body and fistulæ; with a strong spicular rind. Skeleton-spicules acerate to cylindrical.

Genus Rhizochalina (Schmidt).

Flesh-spicules absent.

Rhizochalina putridosa (Lamarck ?).

Large, massive, subspherical. Upper surface bearing numerous short closed fistulæ directed upwards. Pale yellow. Texture dense. Surface uneven. Skeleton arranged as in *R. fistulosa*, Bk. Spicules slightly curved, abruptly but fairly sharply pointed acerates; size ·195 by ·013 millim.

Localities. Station 162, Bass Straits, 38 fath.; off Port Jackson, 30–35 fath.; off Bahia (?).

Rhizochalina pedunculata, n. sp.

Roundedly elongate, narrowing below into a short stout peduncle; height $1\frac{5}{8}$ inch, breadth 1 inch. Fistulæ very short (? all broken off). Brownish yellow. Rind very thin, like paper. Surface rugose. Texture compact. Skeleton arranged much as usual; bast-layer very thin, with fibres compact. Spicules slightly curved acerates, sometimes blunted, measuring up to about ·25 by ·009 millim.; also in the dermal reticulation occasional cylindricals, size variable.

Locality. Api, New Hebrides, 60–70 fath.

Genus Oceanapia (Norman).

Bihamate flesh-spicules present.

[*Oceanapia robusta*, Bk.

Locality. Bahia (?).]

Subfamily ii. *Gelliina.*

Skeleton-spicules acerate. Flesh-spicules present, viz. bihamates or tricurvates. No rind or fistulæ.

* ἕτερος, different; ῥαφὶς, needle.

Genus Gellius (Gray).

Very little horny matter, never forming distinct fibre.

Gellius carduus, n. sp.

Sessile, oval, small. Greyish yellow. Texture loose but firm; interior cavernous. Surface with numerous angular projections, many with oscula at summits. Dermal membrane distinct. Large subdermal cavities. Skeleton:—(*a*) dermal, a unispicular reticulation; (*b*) main, loose, with no definite fibres. Spicules blunted acerates, curved, rounded at each end, size ·6 by ·023 millim. Bihamates of usual shape, size ·02 by ·0012 millim.

Localities. Station 148 *a*, Crozet Island, 240–550 fath.; off Prince Edward's Island, 85–150 fath.; off Marion Island, 50–75 fath.; Station 311, south-west coast of Patagonia, 245 fath. (var. *magellanica*).

Gellius lævis, n. sp.

Massive, sessile, large. Surface smooth; oscula large and even with surface; spiculation as in *G. carduus*.

Locality. Station 320, off Rio de la Plata, 600 fath.

Gellius glacialis, n. sp.

Massive, sessile, globular, lobate, or cylindrical; size up to 3¼ inches long by 1¼ broad. Colour pale greyish yellow. Texture firm but very brittle. Surface even. Dermal layer distinct, flaking off. Vents large, scattered, even with surface. Skeleton arranged as usual. Spicules large stout acerates, slightly curved, sharply and rather suddenly pointed, size ·65 by ·036 millim. Bihamates large, of usual shape, size up to ·07 by ·0063 millim.

Localities. Station 142, Agulhas Bank, 150 fath.; Station 145, Prince Edward's Island, 75 fath. (var. *nivea*).

Gellius flagellifer, n. sp.

Massive, sessile. Diameter about 1 inch. Pale greyish yellow. Soft and brittle. Surface even. Skeleton an irregular reticulation of very loose spiculo-fibre. Spicules slightly curved acerates, tapering to sharp points, size ·42 by ·018 millim. Bihamates very long, much curved, doubled on themselves, size ·06 by ·0021 millim. (smaller ones also present).

Locality. Off Marion Island, 50–75 fath.

Gellius calyx, n. sp.

Hollow pyriform body, with round opening at summit and long slender stalk; length $3\frac{1}{3}$ inches. Greyish yellow. Body soft and fragile, stem hard and stringy. Surface minutely hirsute. Skeleton loosely fibrous in body, compactly fibrous in stem. Spicules:—(1) sharply and gradually pointed acerates, sometimes tending to become blunt, size ·7 by ·022 millim.; (2) bihamates of usual shape, ·02 by ·002 millim.

Locality. Station 320, off Rio de la Plata, 600 fath.

Gellius flabelliformis, n. sp.

Erect, compressed, forming thin lamellæ (? cup-shaped). Greyish yellow. Very fragile. Surface even. Vents? minute, abundant, on concave surface. Pores numerous, on convex surface. Skeleton a loose, irregular reticulation of spicules. Spicules:—(1) large acerates, sharply pointed, slightly bent, size ·7 by ·03 millim.; (2) bihamates, much curved, stout, ·07 by ·0063 millim.; (3) tricurvates smooth, with very obtuse central angle, very large, size ·18 by ·0063 millim.

Locality. Station 320, off Rio de la Plata, 600 fath.

Genus Gelliodes (Ridley).

Distinct and well-developed fibre, with more or less spongin. Bihamates present.

Gelliodes poculum, n. sp.

Consisting of a thin incrusting lamella, from which arise large funnel-shaped calices. Brownish yellow. Texture soft, spongy, but very tough and fibrous. Surface uneven but fairly smooth. Skeleton:—(*a*) main, a reticulation of stout horny matter, sparsely cored by uniserially arranged spicules; (*b*) dermal, a closer reticulation of stout horny fibre, with few axial spicules, but echinated abundantly by tufts of outwardly projecting spicules. Spicules:—(1) short fusiform acerates, sharp-pointed, slightly curved, size ·2 by ·014 millim.; (2) large slender bihamates, size ·12 by ·004 millim.

Locality. Port Jackson, 30–35 fath.

Genus Toxochalina (Ridley).

Fibre as in typical Chalinina, but tricurvate flesh-spicules present.

[*Toxochalina robusta*, Ridley.

Locality. Off Bahia, 7–20 fath.]

Subfamily iii. *Tedaniina.*

Spicules acuate and cylindrical (the latter chiefly dermal), and long hair-like trichites.

Genus Tedania (Gray).

Acuates smooth.

Tedania commixta, n. sp.

Massive, amorphous. Creamy yellow. Soft and compact, with much foreign matter. Surface slightly corrugated. Dermal membrane thin, distinct. Skeleton of loose wisp-like fibres. Spicules:—(1) hastately-pointed acuates, slightly curved, size ·3 by ·0042 millim.; (2) bicapitate cylindricals with slightly developed oval heads, size ·35 by ·004 millim.; (3) fine hair-like trichites, ·13 millim. long.

Locality. Station 162, Bass Strait, 38 fath.

Tedania massa, n. sp.

Massive, cake-like, attaining enormous dimensions. Very soft and spongy. Surface fairly even, very minutely hispid. Vents scattered, level with surface. Skeleton loosely reticulate. Spicules:—(1) stout acuates, curved, subhastately pointed, often blunted, size ·7 by ·03 millim.; (2) cylindrical, straight, hastately pointed, sometimes with small heads, size ·45 by ·013 millim.; (3) acerate trichites up to ·8 millim. long, often collected into fibres.

Localities. ? Station 163 d, New South Wales, 120 fath.; Station 313, east of Straits of Magellan, 55 fath.; Station 320, off Rio de la Plata, 600 fath.

Tedania infundibuliformis, n. sp.

Erect, lamellar, funnel-shaped. Height 2½ inches, breadth 2 inches. Pale yellow. Soft and very fragile. Vents small, scattered on inside of cup. Skeleton a loose, slightly fibrous reticulation of rather slender acuates, with bicapitate cylindricals, in tufts or scattered, at the surface. Spicules:—(1) almost straight slender acuates, sharply and rather suddenly pointed, size ·54 by ·015 millim.; (2) slender bicapi-

tate cylindricals with oval heads, size ·28 by ·0063 millim.; (3) slender trichites, size ·35 by ·002 millim.

Locality. Off south-west coast of Patagonia.

Tedania actiniiformis, n. sp.

Sessile, cylindrical, attached by narrowed base; abruptly truncate above, forming a flat surface, which bears small oscular tubes. Height $\frac{3}{4}$ inch. Colour greyish brown. Texture soft and spongy. Pores in a definite narrow zone about $\frac{1}{12}$ inch below top, very abundant. Main skeleton a diffuse and irregular reticulation of acuates. Dermal reticulation below the pore-zone irregular, above it forming a low wall of thickly-packed, vertically-disposed acerates (cylindricals). Spicules:—(1) stout, slightly curved, rather blunt acuates, size ·87 by ·03 millim.; (2) hastately-pointed cylindricals, size ·56 by ·019 millim.; (3) acerate trichites, size ·56 by ·0031 millim.

Locality. Station 299, off Valparaiso, 2160 fath.

Genus Trachytedania (Ridley).

Acuates spined.

Trachytedania patagonica, n. sp.

Massive, amorphous. Pale yellow. Soft and crumbling. Skeleton a very loose and irregular reticulation of spicules, with tufts of acerates (cylindricals) near the surface. Spicules:—(1) rather stout, slightly curved, entirely spined acuates, size ·35 by ·0125 millim.; (2) short, straight acerates (cylindricals), subfusiform, somewhat hastately pointed, size ·245 by ·007 millim.; (3) very fine acerate trichites, length about ·2 millim.

Locality. Station 308, off south-west coast of Patagonia, 175 fath.

Subfamily iv. *Desmacellina.*

(Characters as given for the sole genus, *Desmacella.*)

Genus Desmacella (Schmidt).

Skeleton-spicules acuate to spinulate. Flesh-spicules bihamates or tricurvates or both.

[*Desmacella annexa*, Schmidt.

Locality. Station 24, West Indies, 390 fath.]

Subfamily v. *Vomerulina.*

Characterized by the presence of a trenchant bihamate spicule *.

Genus Vomerula (Schmidt).

Skeleton-spicules acuate. Flesh-spicules large trenchant bihamates, to which others may be added.

Vomerula esperioides, n. sp.

Erect leaf-like expansions, up to 10 inches high. Pale yellow. Surface uneven, conulose. Dermal membrane thin and transparent, with well-marked skeleton reticulation; subdermal cavities large and irregular. Texture tough and coarsely fibrous. Vents upon small thin-walled tubular projections. Spicules:—(1) smooth acuates, size ·7 by ·019 millim.; (2) large trenchant bihamates, contort, notched at the inner angles and in the centre of the shaft, as in Bowerbank's figure (*l. c.*), length ·177 millim., breadth of shaft ·019 millim.; (3) small bihamates of the usual kind, length ·038 millim.

Localities. Station 142, Agulhas Bank, Cape of Good Hope, 150 fath., abundant; Station 320, off Rio de la Plata, 600 fath., one fragment.

Family 3. **Desmacidonidæ.**

Skeleton-spicules of various forms. Anchorate flesh-spicules normally present.

Subfamily i. *Esperina.*

Fibre not echinated by laterally projecting spicules.

Genus Esperella † (Vosmaer).

Skeleton-spicules smooth, acuate to spinulate. Flesh-spicules palmate inequianchorates, to which may be added bihamates &c. Main skeleton with conspicuous primary fibres.

Esperella mammiformis, n. sp.

Sessile, hemispherical, about $\frac{2}{3}$ inch in diameter, with short

* *Vide* Bowerbank, Mon. Brit. Spong. vol. i. pl. v. fig. 112.
† *Esperia*, Nardo.

oscular projections (usually one only) at summit. Greyish yellow. Soft and stringy. Spicules:—(1) slender acuate, finely pointed, size 1·0 by ·019 millim.; (2) palmate inequianchorates, with well-rounded palm, length ·072 millim., breadth of palm ·034 millim.

Locality. Station 147, east of Prince Edward's Island, Southern Ocean, 1600 fath.

Esperella lapidiformis, n. sp.

Massive, sessile, boulder-like (size $5\frac{1}{4}$ by $3\frac{1}{2}$ by $2\frac{3}{4}$ inches). Soft but fibrous, minutely hispid. Vents numerous short wide tubular processes, confined to the summit. Spicules:—(1) acuate, tending to spinulate, rather sharp-pointed, size ·9 by ·02; (2) large palmate inequianchorate, with three strong teeth at each end, size ·094 millim. long.

Locality. Station 320, off Rio de la Plata, 600 fath.

Esperella murrayi, n. sp.

Massive, lobate, sessile, with narrowed base. Height $6\frac{1}{2}$ inches; greatest breadth $4\frac{2}{3}$ inches. Pale yellow. Hard and dense. Surface smooth and even except for numerous meandering cracks (pore-areas), which form a reticulation everywhere, except on the summits of the lobes. Vents grouped on summits of lobes, about $\frac{1}{6}$ inch in diameter. Pores in the cracks of the surface, reducing the dermal membrane here to a sieve. Dermal skeleton a dense felted layer of acuate spicules. Spicules:—(1) acuate, slightly fusiform, size ·7 by ·019 millim.; (2) large palmate inequianchorates, length ·072 millim., breadth of palm ·019 millim.; (3) bihamates, often much contort, size ·053 by ·0024 millim.; (4) trichite bundles, size ·076 by ·013 millim.

Locality. Off Port Jackson, 30–35 fath.

Esperella porosa, n. sp.

Cylindrical, diameter about $\frac{1}{4}$ inch. Fibrous but rather soft. Surface minutely hispid, but with a porous appearance, due to the close reticulation of the dermal skeleton. Vents few, small. Dermal skeleton a compact reticulation of dense spiculo-fibre with meshes ·3 millim. wide. Spicules:—(1) spinulate, sharp-pointed, with small heads, size ·38 by ·016 millim.; (2) palmate inequianchorates, length ·05 millim., with long narrowed palm at large end; (3) large simple and contort bihamates, size ·16 by ·0085 millim.

Locality. Off Port Jackson, 30–35 fath.

Esperella nuda, n. sp.

Incrusting (?). Pale yellow. Soft, minutely hispid. Dermal membrane thin and transparent; pores in groups, groups scattered. Spicules:—(1) spinulate, with small head, abruptly sharp-pointed, size ·245 by ·016 millim.; (2) palmate inequianchorates, with long narrow palm at large end, length ·025 millim.; (3) simple and contort bihamates, size ·12 by ·0063 millim.

Locality. Off Bahia, shallow water.

Esperella fusca, n. sp.

Sublobose, rounded. Dark greyish brown. Soft, resilient. Vents few, with slightly tubular margins. Pores scattered. Spicules:—(1) spinulate, with distinct oval head and usually much blunted apex, size ·455 by ·0126 millim.; (2) palmate inequianchorates, length up to ·063 millim.; (3) slender, usually much contort bihamates, length ·044 millim.; (4) small compact oblong trichite bundles, size ·0315 by ·0063 millim.

Locality. Off Bahia, 17 fath.

Esperella arenicola, n. sp.

Massive, flat, cake-like (largest measuring 7 by $3\frac{1}{4}$ by $\frac{2}{3}$ inch). Light brown. Brittle, extremely sandy. Dermal membrane thin and transparent. Vents small and scattered. Skeleton very loose. Spicules:—(1) long and very slender spinulate, with distinct head and sharp point, size ·4 by ·0072 millim.; (2) small, slender, palmate inequianchorates, ·028 millim. long; (3) simple and contort bihamates, size ·077 by ·0048 millim.; (4) large trichite bundles, size ·35 by ·07 millim.

Locality. Station 162, Bass Strait, 38 fath.

Esperella simonis, n. sp.

Ramose, cylindrical, or more or less massive. Fibrous, elastic. Minutely hispid. Pores scattered. Spicules:—(1) spinulate, with small heads, sharply and gradually pointed; size ·4 by ·0145 millim.; (2) large palmate inequianchorates, ·072 millim. long, with palm ·036 millim. wide, the small ends abruptly truncated, and often attached to the spiculofibre; (3) large, stout, contort bihamate, size ·24 by ·019 millim.; (4) smooth tricurvates, size ·145 by ·003 millim.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fath.

Esperella biserialis.

Consisting of a long, straight, slender axis, somewhat flattened, giving off short, slender, spicular processes in two opposite series along the margins; coated by a thin crust of soft tissues. Length of sponge $3\frac{2}{3}$ inches, longer diameter $\frac{1}{24}$ inch. Surface hispid. Spicules:—(1) long, slender, fusiform acuates, very thin at both ends, length may reach over 2·0 millim., diameter ·038 millim.; (2) spinulates, hastately pointed, size ·44 by ·01 millim. (dermal); (3) minute palmate inequianchorates, length ·0126 millim.; (4) small slender bihamates, length ·025 millim.

Localities. Station 281, South Pacific, 2385 fath.; Station 291, South Pacific, 2250 fath.

Genus Esperiopsis (Carter).

Acuate or subspinulate skeleton-spicules and palmate equianchorate flesh-spicules.

Esperiopsis symmetrica, n. sp.

Erect, slender, cylindrical, covered with numerous long, slender, spicular processes, which cause it to resemble a bottle-brush. Diameter $\frac{1}{6}$ inch (including spicular processes). Colour dark chocolate-brown. Skeleton radiately arranged, but with no definite central axis. Spicules:—(1) slender, fusiform, subspinulate, size about ·8 by ·028 millim. (or slenderer); (2) large palmate equianchorates, length ·037 millim.; (3) very minute slender bihamates, length ·013 millim.; (4) much larger, very slender bihamates, rather scarce.

Locality. Off Prince Edward's Island, Southern Ocean, 310 fath.

Esperiopsis cylindrica, n. sp.

Erect, cylindrical, dichotomously branched. Height 11 inches. Yellowish grey. Hard and tough, minutely hispid. Skeleton a central core of dense horny fibre, covered by a thin coat of granular choanosome. Spicules chiefly imbedded in spongin in the axis and in fibres radiating to the surface. Spicules:—(1) smooth acuates, (*a*) stout, up to ·7 by ·023 millim., (*b*) slender, up to ·7 by ·0063 millim.; (2) small palmate equianchorates, length ·025 millim.; (3) smooth tricurvates, ·07 millim. long (? foreign).

Locality. Off Port Jackson, 30–35 fath.

Esperiopsis challengeri (Ridley) *.

The best idea of the external form of this sponge will be obtained from the figure referred to *. Erect, stipitate, giving off branches on one side only, each of which terminates in a concave lamellar expansion. Length up to about 8 inches, with six or seven lamellæ. Light yellow. Stem densely fibrous, lamellæ rather fragile and soft. Pores very abundant on concave surface of lamellæ. Vents small, abundant on convex surface of lamellæ. Spicules:—(1) curved acuates, gradually sharp-pointed, size about ·35 by ·0126 millim.; (2) palmate equianchorates, length ·031 millim. This species possesses the most remarkable and beautiful external form of all known Monaxonid sponges.

Localities. Station 196, east of Celebes Island, 825 fath., abundant; Station 214, south of Philippines, 500 fath. (var. *meangensis*, fragments only).

Esperiopsis profunda, n. sp.

Stipitate, with narrow tubular head; height up to about 4 inches. Light yellowish grey. Soft and spongy. Hispid. Skeleton very loose in the head. Spicules:—(1) acuate to spinulate, gradually sharp-pointed, size 1·4 by ·0157 millim.; (2) large palmate equianchorates, length up to ·09 millim., but more commonly about ·05 millim.

Locality. Station 147, Southern Ocean, 1600 fath.

Esperiopsis anomala, n. sp.

Digitate; irregularly ramose. Greyish yellow or grey. Soft and compressible, but elastic and very fibrous, *Chalina*-like. Dermal membrane delicate and transparent. Skeleton:—(*a*) dermal, loose tufts of spicules; (*b*) main, rectangular, composed of stout spiculo-fibre with much spongin and few spicules. Spicules:—(1) long slender acuates, tending to subspinulate, sharp-pointed, size about ·25 by ·005 millim., but commonly longer and slenderer; (2) very rare, very minute, very slender equianchorates, length about ·01 millim.

Locality. Honolulu, 16–20 fath.

Esperiopsis (?) *pulchella*, n. sp.

Very small, thin patches of a blackish colour, incrusting a *Myxilla*. Pores in definite areas or sieves, each area about

* *Amphilectus challengeri*, Ridley, Narr. of Cruise of H.M.S. 'Challenger,' vol. i. pt. 2, p. 570, fig. 187.

·45 millim. in diameter, visible to the naked eye as a minute lighter-coloured oval spot on the surface. Colour due to very numerous minute cells of a blackish-green colour. Spicules:—(1) acuate or subspinulate, sharp-pointed, usually with several slight bulbous inflations along the shaft, size ·3 by ·0063 millim.; (2) palmate equianchorates, large, and of peculiar shape, length ·1 millim., the young forms very short and broad, with the two front palms united by their apices; (3) very minute, slender equianchorates, of the ordinary "Amphilectus" type, length ·015 millim.

Locality. Station 192, S.W. off New Guinea, 140 fath.

Genus CLADORRHIZA (Sars).

External form usually definite and symmetrical. Skeleton-spicules acuate or (and) spinulate. Characteristic flesh-spicule inequianchorate, with three or more claw-like teeth at each end, and a curved shaft expanded laterally into wing-like processes, especially near the large end.

Cladorrhiza moruliformis, n. sp.

A small globular head perched on the summit of a stalk. Head conulose, owing to the ends of radiating skeleton-fibres; like a mulberry; diameter, excluding the conuli, $\frac{5}{12}$ inch. The stalk is prolonged through, and projects for a short way above, the head. Colour (dry) white. Skeleton composed chiefly of a main longitudinal axis giving off stout radiating fibres in the head. Spicules:—(1) straight, slender acuates, reaching over 2·0 millim. long, diameter ·05 millim., hastately pointed; (2) inequianchorates with three prominent teeth at each end, length ·063 millim.; (3) large, contort bihamates, size up to ·35 by ·145 millim.

Locality. Station 157, Southern Ocean, 1950 fath.

Cladorrhiza longipinna *, n. sp.

Consisting of a subglobular body, somewhat flattened below, with a fringe of very long fine supporting processes (twenty-five or thirty) projecting outwards and downwards, while a circlet of very short stiff processes crowns the summit of the body. From the centre of the lower surface depends a long

* For the very remarkable external shape which characterizes this and certain other species we propose the name "*Crinorrhiza-form*" after Schmidt's genus *Crinorrhiza*. The function of the long radiating processes is evidently to support the sponge on the soft mud on which it lies.

root-like process. Diameter of body $\frac{1}{5}$ inch, length of supporting processes $\frac{3}{4}$ inch. Pale yellow. Spicules:—(1) long slender acuates of various sizes, the longest in the main fibres; (2) small tridentate inequianchorates, length ·034 to ·06 millim.

Locality. Station 264, North Pacific, 3000 fath.

Cladorrhiza similis, n. sp.

Sponge of *Crinorrhiza*-form, consisting of a conical body with a root-like process depending from the centre of the base, and with a fringe of long stiff supporting processes radiating outwards and downwards. Diameter of base of cone $\frac{1}{4}$ inch. Colour dirty yellow. Spicules:—(1) very long slender acuates, as usual, forming the fibres of the various processes; (2) short inflated spinulates with distinct head, sharp-pointed, length from ·21 to ·595 millim., thickness about ·016 millim., thickly scattered near the surface of the sponge; (3) tridentate equianchorates as usual, length about ·0315 millim.

Locality. Station 281, South Pacific, 2385 fath.

Cladorrhiza inversa, n. sp.

Sponge of *Crinorrhiza*-form. Consisting of a small conical body, produced upwards into a long slender process; base of cone nearly flat, with a fringe of short stiff processes radiating outwards and downwards, and a single very short stiff process projecting downwards from near the centre. Diameter of base $\frac{1}{9}$ inch. Spicules:—(1) large, slender, fusiform, blunt-pointed acuates, size about 2·0 by ·0375 millim. (but variable), forming the main fibres; (2) scattered fusiform spinulates, sharp-pointed and with club-shaped heads, size about ·63 by ·0189 millim.; (3) tridentate equianchorates, with much-expanded shaft, length ·03 millim.; (4) bihamates (?).

Locality. Station 332, South Atlantic, 2200 fath.

Cladorrhiza tridentata, n. sp.

Sponge small, hemispherical. One surface slightly concave with inwardly-turned margin; the other convex, sometimes attached. Height $\frac{1}{4}$ inch, diameter $\frac{1}{2}$ inch. Pale greyish yellow, soft and yielding. No distinct fibres in the skeleton. Spicules:—(1) long very slender spinulates, fusiform, with very small head, gradually and finely pointed, size about ·7 by ·0155 millim.; (2) large inequianchorates, with stout, strongly-curved shaft bearing large wing-like lateral processes, and with three stout sharp teeth at each end, length about ·076

millim.; (3) slender bihamates, size about ·09 by ·0032 millim.

Locality. Station 147, between Prince Edward's and Crozet Islands, 1600 fath.

Genus Trochoderma *, n. g.

Acuate skeleton-spicules and inequianchorate flesh-spicules of the *Cladorrhiza*-type; also the characteristic spicules of the genus, consisting each of a long straight shaft with (usually) five equal teeth arranged in a star at each end.

Trochoderma mirabile, n. sp.

Sponge of the *Crinorrhiza*-form. Consisting of a conical body with concave lower surface. Margin fringed with numerous (thirty or forty) very long spicular processes, projecting outwards and downwards. From the centre of the lower surface depends a long slender root-like process. The summit of the body is produced into a papilla bearing numerous, very short, slender spicular processes. Diameter of body $\frac{1}{4}$ inch. Spicules:—(1) straight, slender acuates, which may attain a length of over $3\frac{1}{2}$ millim.; (2) tridentate equianchorates of the usual *Cladorrhiza*-type, length about ·038 millim.; (3) bihamates, with the ends produced into slender whip-like processes, length ·076 millim. †; (4) large spicules with stout, straight, cylindrical shaft, and a rosette of usually five teeth at each end, length up to ·23 millim. These spicules form a dense layer incrusting the body.

Locality. Station 291, South Pacific, depth 2250 fath.

Genus Chondrocladia (Wy. Thomson).

Usually of symmetrical external form. Skeleton-spicules acuate to spinulate. Characteristic flesh-spicules equianchorates, with curved shaft expanded laterally near each end, and with three or more teeth at each end.

Chondrocladia stipitata, n. sp.

A spherical head perched on the end of a long stalk. Diameter of head about $\frac{1}{2}$ inch, length of stalk 1 inch, attached at the base. Pale yellow. Soft, hispid. Spicules:—(1) long, sharp-pointed, fusiform spinulates, with very faintly marked heads, size up to 2·2 by ·038 millim.; (2) large equianchorates with curved shafts bearing five prominent claw-like

* τροχός, a wheel; δέρμα, the skin.

† The length of bihamate spicules is always measured from bend to bend.

teeth at each end, lateral processes well developed, length ·085 millim.; (3) slender bihamates, length ·055 millim.

Locality. Station 147, between Prince Edward's and Crozet Islands, 1600 fath.

Chondrocladia clavata, n. sp.

A very small globular head perched on the end of a slender stalk, which is short, and at the bottom breaks up into a tuft of rootlets. From various parts of the head radiate long slender processes. Diameter of head about $\frac{1}{12}$ inch. Pale yellow. Spicules:—(1) slender acuates, size variable, up to 1·0 by ·022 millim.; (2) tridentate equianchorates of the usual *Chondrocladia*-type, length ·057 millim.; (3) bihamates about ·044 millim. long. This sponge makes a near approach to the typical *Crinorrhiza*-form.

Locality. Station 174, Fiji Islands, 140 fath.

Chondrocladia crinita, n. sp.

Sponge of the *Crinorrhiza*-form; consisting of a conical body, terminating above in a spike-like projection. Base fringed by a number of long, coarse, hair-like processes, and with a stout papilla projecting from its centre. Diameter of base $\frac{7}{12}$ inch. Brownish yellow. Spicules:—(1) slender acuates, size in the main fibres about 2·2 by ·044 millim; (2) large, tridentate equianchorates of the usual *Chondrocladia*-form, length about ·1 millim.; (3) slender bihamates, length about ·07 millim.

Locality. Station 216 A, north of New Guinea, 2000 fath.

Genus DESMACIDON (Bowerbank).

Form various. Skeleton-spicules acerate to cylindrical. Flesh-spicules equianchorates and usually bihamates.

Desmacidon reptans, n. sp.

Incrusting other sponges or free, massive, amorphous, or digitate. Greyish yellow. Texture fairly firm, resilient. Vents and pores small and scattered. Dermal skeleton usually well developed, with fibre composed of proper spicules and foreign bodies, and with meshes which vary a good deal in width. Spicules:—(1) smooth acerates, sharply and rather abruptly pointed, size ·18 by ·008 millim.; (2) equianchorates, with three sharp teeth at each end, and no palms, length ·019 millim; (3) simple or contort bihamates, about ·038 millim. long.

Locality. Off Bahia, 7–20 fath.

Desmacidon conulosa, n. sp.

Consisting of a stout peduncle expanding above into broad flattened lobes. Height $3\frac{3}{4}$ inch. Greyish yellow. Firm, tough, resilient. Surface conulose. Vents small, scattered over both surfaces. Skeleton, a coarse reticulation of stout fibre with little spongin. Spicules:—(1) stout, fusiform, gradually sharp-pointed acerates, size ·7 by ·057 millim.; (2) small palmate equianchorates with large anterior palms, length ·032 millim.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fath.

Desmacidon (?) *ramosa*, n. sp.

Consisting of irregular, vermiform, anastomosing branches about $\frac{1}{4}$ inch in diameter. Pale greyish yellow. Tough and leathery. Surface minutely hispid, often with a reticulate appearance. Vents scattered, with their margins slightly produced. Skeleton composed of a central axis of spiculo-fibre from which bands of fibre radiate to the surface, beneath which they break up into divergent tufts of spicules, which support the dermal membrane and sometimes project beyond it. Spicules:—(1) sharp-pointed, fusiform acerates, size ·6 by ·022 millim.; (2) tridentate equianchorates, the shafts of which appear to be extended into slight lateral processes, length ·02 millim.

Localities. Station 142, south of Cape of Good Hope, 150 fath.; off Marion Island, 50–75 fath.

Subgenus HOMŒODICTYA (Ehlers).

Differing from *Desmacidon* in the form of the equianchorate spicule. This has a distinct anterior palm, usually slightly curved outwards at the free end and always giving off in the median line a backwardly projecting process, which, when viewed laterally, gives to the anterior palm a forked appearance. Usually also the shaft of the spicule is laterally expanded all the way along *.

Homœodictya kerguelenensis, n. sp.

Lobate or digitate. Light brownish yellow. Soft, spongy, resilient. Surface woolly-looking and minutely hispid. Vents small and scattered. Skeleton very loose and ill-defined. Spicules:—(1) short, stout, sharp-pointed acerates, size ·35 by ·0189 millim.; (2) palmate equianchorates of the typical

* For an excellent figure of this spicule *vide* Carter, Ann. & Mag. Nat. Hist. 1882, vol. x. p. 111, fig. 1, *a*, *b*.

form, anterior palms oval, may be slightly turned out at the end, shaft with a delicate lateral expansion all the way along, length ·028 millim.

Locality. Royal Sound, Kerguelen, 25 fath.

Homœodictya grandis, n. sp.

The single specimen consists of a large, broad, very much flattened lamella, presumably of erect growth, at the upper edge proliferating into compressedly digitate branches. Greatest breadth of specimen 11 inches, greatest height 6 inches, thickness $\frac{1}{10}$ to $\frac{1}{4}$ inch. Greyish yellow. Firm, tough, fibrous, resilient. Surface fairly even, but minutely conulose and minutely hispid. Vents small, in stellate groups of about four each, on one side only of the frond; very abundant. Skeleton well developed, composed of stout Axinellid-like spiculo-fibre. Spicules:—(1) stout, fusiform acerates, bent in the middle, gradually sharp-pointed, size ·45 by ·04 millim.; (2) large palmate equianchorates of the usual type, but with the middle portion of the shaft not laterally expanded, though often with an irregular swelling, length ·063 millim.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fath.

Genus ARTEMISINA (Vosmaer).

Sponge compact, texture cork-like, as in typical *Suberites*. Skeleton-spicules acuates or subspinulates. Flesh-spicules equianchorates, and tricurvates with spined ends.

[*Artemisina suberitoides*, Vosmaer.

Locality. Station 49, south of Nova Scotia, 85 fath.]

Genus PHELLODERMA *, n. g.

Corticate, with cork-like rind. Skeleton radiately arranged. Skeleton-spicules smooth acuates. Flesh-spicules equianchorate.

Phelloderma radiatum, n. sp.

Subglobular, with concave base of attachment, $\frac{1}{2}$ inch in diameter, with cork-like cortex ·24 millim. thick. Light brown. Vents (? few, scattered, each on a small papilla). Skeleton radiately arranged, fibres terminating at the surface in brushes of spicules whose points are imbedded in the dense cortex. Spicules:—(1) straight acuates or subspinulates, gradually sharp-pointed, with the shaft slightly bulbously dilated

* φελλὸς, cork; δέρμα, skin.

at intervals, size ·65 by ·0126 millim.: (2) equianchorates of characteristic form, with three rather palmate teeth at each end, and diamond-shaped "tubercle" (*Carter*); often the two anterior teeth are united by their apices to one another; length ·044 millim. The sponge also contains a good deal of sand.

Locality. Station 320, off Rio de la Plata, 600 fath.

Genus Sideroderma *, n. g.

Sponge with mammiform projections and a dense external rind of closely packed, horizontally laid skeleton-spicules, and a soft internal "choanosome" (*Sollas*). Skeleton-spicules: smooth, bicapitate cylindricals. Flesh-spicules: equianchorates, trichites, and (usually) bihamates.

Sideroderma navicelligerum (Ridley) †.

Hemispherical, sessile. Rind hard and dense, composed of densely packed bicapitate cylindricals; about 1 millim. thick. Surface covered by numerous papillæ, some vent-bearing. Pale yellow. Spicules:—(1) bicapitate cylindricals with a long cylindrical shaft and an oval head at each end, length ·28 to ·595 millim., diameter in middle of shaft ·0063 to ·0126 millim.; (2) very fine long trichites, in bundles measuring about ·45 by ·17 millim.; (3) contort bihamates, large, measuring ·06 by ·0047 millim., and small measuring ·0189 by ·0015 millim.; (4) tridentate equianchorates, length ·019 millim.; (5) very minute equianchorates of peculiar form, shaft much expanded laterally all along, so as to become oval and flattened, and notched in front in the centre, with one small oval tooth at each end, sharply recurved; length ·01 millim.‡

Locality. Station 188, off New Guinea, 28 fath.

Genus Iophon (Gray).

Skeleton-spicules:—(1) dermal, cylindrical, usually bicapitate; (2) main, acuate, generally more or less spined. Flesh-spicules:—(1) palmate inequianchorates, the small end

* σίδηρος, iron; δέρμα, the skin.

† "*Crella navicelligera*, Ridley, Voyage of H.M.S. 'Challenger,' Narr. of Cruise, vol. i. part 2, p. 571.

‡ We are indebted to the kindness of Dr. R. v. Lendenfeld for the opportunity of examining a second species of this remarkable genus, which occurs in his large collection, whereby we have been able to give a more satisfactory generic diagnosis than would otherwise have been the case.

terminating in a sharp spur (constant); (2) bipocillate spicules* (almost always present).

Iophon chelifer, n. sp.

Massive, honeycombed. Light brown to black. Soft and crumbling. Skeleton loose. Spicules:—(1) spined acuates, size ·4 by ·02 millim.; (2) bicapitate cylindricals, size ·3 by ·01 millim., with microspined heads; (3) palmate inequianchorates as usual, ·019 to ·03 millim. long; (4) large bipocillated spicules ·019 millim. long, of very peculiar form, shaft narrow and much bent, small end clawed, with two prongs, large end bearing two, three, or four expanded, flattened flukes, which together form a cup.

Localities. Station 142, off Cape of Good Hope, 150 fath.; Station 145 A, off Prince Edward's Island, 310 fath.; Station 148 A, between Prince Edward's and Kerguelen Islands, 550 fath.

Iophon cylindricus, n. sp.

Erect, cylindrical; diameter $\frac{1}{4}$ inch. Brown. Brittle and crumbling. Spicules:—(1) bicapitate cylindricals with smooth shaft and distinct, microspined heads, size ·22 to ·29 by ·008 millim.; (2) smooth acuates, sharp-pointed, size ·29 by ·01 millim.; (3) palmate inequianchorates as usual, length ·025 millim.; (4) bipocillates of usual shape, length ·0127 millim.

Locality. Station 163 A, off Cape Howe, Australia, 120 fath.

Iophon laminalis, n. sp.

A number of irregular, flat or slightly curved, cake-like expansions; possibly cup-shaped when perfect. Thickness of lamellæ $\frac{1}{6}$ to $\frac{2}{3}$ inch. Dark reddish brown. Texture loose, crumbling. Spicules:—(1) bicapitate cylindricals, heads sometimes microspined, size ·34 by ·0013 millim.; (2) large, smooth subspinulates, size ·63 by ·022 millim., rather abruptly sharp-pointed; (3) palmate inequianchorates, ·025 millim. long; (4) bipocillates, ·013 millim. long, consisting of a curved shaft with a large cup-shaped expansion at one end and a small one at the other.

Locality. Station 145 A, off Prince Edward's Island, 310 fath.

* For a figure of this spicule *vide* Bowerbank, 'Mon. Brit. Spong.' vol. i. pl. v. figs. 124, 125, 126.

Iophon abnormalis, n. sp.

Cylindrical, branched; brittle and crumbling. Black. Spicules:—(1) bicapitate cylindricals with spined heads, size ·28 by ·008 millim.; (2) acuates, generally spined at the base and also slightly at the apex, size ·35 by ·0126 millim.; (3) large palmate inequianchorates, ·0378 millim. long, and of the usual *Iophon* type, chiefly in rosettes. Also smaller ones of about half the size, but not in rosettes. No bipocillates.

Locality. Off Marion Island, 50–75 fath.

Genus AMPHILECTUS (Vosmaer).

We make use of this genus in the manner indicated by its founder, namely, as a provisional receptacle for a number of species of doubtful position.

Amphilectus apollinis, n. sp.

Massive, amorphous. Light greyish yellow. Rather soft and spongy. Skeleton loose, confused. Spicules:—(1) slender acuates or subspinulates, gradually sharp-pointed, often microspined at the base, size ·315 by ·0063 millim. (dermal); (2) stout, smooth acuates, size ·5 by ·0168 millim. (in main skeleton); (3) small palmate equianchorates, length ·015 millim.; (4) large tricurvates with spined ends, size ·3 by ·0045 millim.

Locality. Royal Sound, Kerguelen, 20–60 fath.

Amphilectus ceratosus, n. sp.

Massive, lobate. Dark reddish brown. Spongy, elastic, but fairly compact. Surface glabrous, but with small angular conuli. Vents small and scattered. Skeleton:—(*a*) main, a reticulation of horny fibre, 07 millim. thick, with no spicular core, and irregularly scattered spicules, which occur also in wisps near the surface; (*b*) dermal, irregularly scattered spicules. Spicules:—(1) smooth bicapitate cylindricals with oval heads, size ·24 by ·003 millim.; (2) palmate equianchorates, length ·025 millim.

Locality. Off Port Jackson, 7 fath.

Amphilectus pilosus, n. sp.

Pedunculate, lobate. Dark chocolate-brown; texture coarse and hairy, but rather compact. Surface pilose, shaggy, with deep longitudinal grooves. Spicules:—(1) bicapitate cylindricals, heads usually microspined, size ·42 by

·0063 millim. (dermal); (2) smooth acuates, size up to 2·0 by ·025 millim.; (3) acerates—(*a*) small, tricurvate, size about ·35 by ·0063 millim., (*b*) large, almost or quite straight, size up to 2·0 by ·01 millim. (*a* and *b* connected by intermediate forms); (4) very minute palmate equianchorates, ·0065 millim. long; scarce.

Localities. Christmas Harbour, Kerguelen, 70 fath.; off Marion Island, 50–75 fath.

Amphilectus annectens, n. sp.

Massive, lobate. Greyish yellow. Soft and spongy. Skeleton very loose and irregular. Spicules:—(1) smooth acuates, gradually sharp-pointed, size 1·0 by ·037 millim.; (2) bicapitate cylindricals, inequiended, ends microspined, size ·525 by ·01 millim. (dermal); (3) small palmate equianchorates, length ·02 millim.; (4) slender tricurvates with faintly spined ends, length up to ·2 millim. (few); (5) usually contort bihamates, length ·063 millim. (few).

Locality. Station 320, off Rio de la Plata, 600 fath.

[To be continued.]

XXXV.—*Contributions to the Study of the Littoral Fauna of the Anglo-Norman Islands (Jersey, Guernsey, Herm, and Sark).* By Dr. R. Kœhler.

[Plate XI.]

[Continued from p. 307.]

HERM.

The island of Herm is situated about 3 miles from the east coast of Guernsey, from which it is separated by a narrow channel, the Little Russel, in which the sea presents exceedingly violent currents. The island of Herm is not much more than half a mile broad and nearly 2 miles in length. The coast, which is nearly perpendicular to the east and especially towards the south, falls with a gentle slope to the north and west. On the west coast the sea in retiring lays bare an immense sandy beach, which extends at spring-tides to a distance of more than half a mile. Thus the surface of the

island is doubled at low water, and the outlines of the island are very different according to the period of the tide. Towards the north the sea exposes a beach of much less extent and sprinkled with rocks.

Communication with the island of Herm is not easy, for the strong currents which prevail around the island do not allow the fishermen to sail there except in very favourable weather; the steam-boat service is not frequent and does not always coincide with the times of low tide. The few excursions which I made to Herm enabled me to ascertain that this station was exceptionally rich. I should like very much to have stayed there for some days, but it is impossible to find accommodation.

At low water the western part of the island presents an immense beach, formed of shell-sand, upon which rise some rocks indicated on the charts by the names of Vermerette, Hermetier, and Hornet. In this beach live a great number of species of animals belonging to very varied types, and of which an abundant harvest may be collected by digging in the sand with a spade. Towards the north-western region of the island, in the vicinity of the Hornet rocks, stretch vast meadows of *Zosteræ*, which are continued to the north of the island, where they give place to numerous rocks. We may therefore distinguish three distinct regions, in each of which the fauna presents a peculiar physiognomy.

I. Shell-Sands.—These sands are composed of fragments of shells, conveyed by the violent currents which prevail around Herm, and thrown up by the sea upon the coast, where they accumulate in considerable quantities. Similar débris are also met with at certain points on the east coast, but do not give shelter to animals; to make up for this the shells are much better preserved than on the west coast, for they are less rolled by the waves, and the conchologist might in a short time collect a great number of interesting forms. The shells which are most frequently found in the shell-sand belong to the species indicated below. I give the enumeration of these species, which really do not belong to the fauna of Herm, since they are only dead remains, to show the variety of specimens which may be collected in these sands.

Gasteropoda.

Patella vulgata, *Linn.*
Helcium pellucidum, *Linn.*
Tectura virginea, *Müll.*
Emarginella fissura, *Linn.*
Fissurella græca, *Linn.*
Calyptræa chinensis, *Linn.*
Trochus magus, *Linn.*
—— cinerarius, *Linn.*
—— umbilicatus, *Mont.*
—— striatus, *Linn.*
—— exasperatus, *Penn.*
—— zizyphinus, *Linn.*
—— tumidus, *Mont.*
Phasianella pulla, *Linn.*
Lacuna divaricata, *Fab.*
Lacuna pallidula, *DC.*
Littorina obtusata, *Linn.*
—— rudis, *Mat.*
Rissoa parva, *DC.*
—— cingillus, *Mont.*
—— cancellata, *DC.*
Odostomia lactea, *Linn.*
Natica catenata, *DC.*
Purpura lapillus, *Linn.*
Murex erinaceus, *Linn.*
Lachesis minima, *Mont.*
Nassa incrassata, *Ström.*
Cypræa europæa, *Mont.*
Dentalium tarentinum, *Lam.*

Lamellibranchiata.

Anomia ephippium, *Linn.*
Pecten pusio, *Linn.*
—— varius, *Linn.*
—— opercularis, *Linn.*
Nucula nucleus, *Linn.*
Pectunculus glycymeris, *Linn.*
Arca lactea, *Linn.*
—— tetragona, *Poli.*
Lucina borealis, *Linn.*
Cardium fasciatum, *Mont.*
—— nodosum, *Turt.*
—— edule, *Linn.*
—— norvegicum, *Sp.*
Venus exoleta, *Linn.*
—— casina, *Linn.*
—— verrucosa, *Linn.*
—— ovata, *Penn.*
Lima hians, *Gmel.*

A careful examination would no doubt enable many other species to be recognized.

The group of animals living in these sands constitutes a very interesting fauna.

The ACTINIÆ are represented by *Bunodes gemmacea*, *Sagartia bellis*, and *Peachia undata*, Gosse. This last species is known to be rather scarce. The figure of it given by Gosse is unsatisfactory, but the species from Herm is easily characterized by its five-lobed conchula and by its tentacles presenting circular bands. The largest specimens may attain a length of nearly 8 inches, with a thickness of from 1 to $1\frac{1}{2}$ inch. The integuments present a fine rose-colour with spots of brick-red. The *Peachia* buries itself very deeply in the sand. To obtain it the hole indicating its presence must be sought on the beach and the spade pushed in quickly, so as not to give the animal time to retire lower down. The *Peachiæ* are associated with *Edwardsiæ*, of which the column presents a very light grey colour and delicate and transparent integuments; these *Edwardsiæ* must be referred to *E. Harrassii*, Quatref.

The ECHINODERMATA are chiefly represented by *Spatangi* and *Echinocardium flavescens*, Müll., which are buried in the sand to a depth of about 4 inches. Their position is easily known by means of the little cone of sand which covers it.

Echinocardium flavescens attains a remarkable size; the largest are not less than about 3 inches long by $2\frac{1}{2}$–$2\frac{3}{4}$ inches wide. They differ from the Mediterranean specimens in the first place by their size and also by their coloration, which is dark grey, never rose-colour, so that the name of *Amphidetus roseus* would not be applicable to them. Upon these specimens I find small pedicellariæ with fleshy valves, of a dark red colour, which I have indicated upon the *Echinocardia* of the Mediterranean. At Herm the *Echinocardia* are rather less frequent than the *Spatangi*. *Synaptæ* (*S. inhærens*) are very abundant.

A NEMERTIAN of very large size lives in these shell-sands; its body, of a dark colour, nearly black, except at the anterior extremity, which is lighter, is flattened and about $\frac{4}{10}$ inch wide and of considerable length. An imperfect specimen which I extracted with much trouble was about 20 inches long; it broke up spontaneously and immediately into a great number of small fragments, just as the *Synaptæ* do. This Nemertian is evidently very nearly allied to the species from the Pouliguen which Giard has described under the name of *Avenardia Priei*, if indeed it is not specifically identical therewith. All that the learned Professor says of that species applies to the animal from Herm; he has remarked that "when taken out of the water, instead of stretching itself softly like *Lineus*, the animal breaks up very rapidly into a multitude of smaller and smaller fragments. When the division ceases the fragments are scarcely more than 2 centimetres [about $\frac{7}{10}$ inch] long, and each of them has acquired a rounded form, in consequence of the contraction of the muscles, which gradually diminishes the fresh surface of the section, and finally causes it to disappear entirely,"—phenomena which I have observed in the Herm *Avenardia*.

Of the POLYCHÆTA, besides *Nephthys Hombergii*, *Aricia Cuvieri*, *Arenicola piscatorum*, and *Sthenelais Edwardsii*, some interesting species live in the sands of Herm. I may mention a large *Glycera* which I refer to *G. alba*, Rathke, and which is very frequent, as also numerous Clymenians:—*Clymene lumbricoides*, Aud. & Edw., *Leiocephalus coronatus*, Quatref., and *Arenia cruenta* and *A. fragilis*, Quatref. In somewhat muddy places, near the portion covered with *Zostera*, I have also taken some examples of *Ammotrypane œstroides*, Rathke. Among the Tubicola, *Terebella conchilega*,

Pall., *Sabella pavonina*, Sav., and *S. arenilega*, Quatref., are very common. But the *Chætopteri* (*C. Valencinii*, Quatref.) especially are abundant on all parts of the shore; they are found almost at every step, and even at points very close to the bank which are laid bare at nearly every tide.

As to the DECAPODA, they are represented by five species:—*Thia polita*, *Corystes cassivelaunus*, *Callianassa subterranea*, *Gebia deltura*, and *Axius stirhynchus*. These species, as is well known, are all fossorial.

MOLLUSCA are also very abundant, and belong to the following species:—*Lutraria oblonga*, Chemn.; *Solecurtus candidus*, Ren.; *Tellina squalida*, Pult.; *Solen ensis* and *S. vagina*, Linn.; *Pectunculus glycymeris*, Linn.; *Psammobia ferroensis*, Chemn.; *Mya truncata*, Linn.; *Cardium norvegicum*, Sp.; *Astarte triangularis*, Mont.; *Donax politus*, Poli; *Mactra glauca*, Born; *Natica Alderi*, Forbes; and *Skenea planorbis*, Forbes.

Amphioxus lanceolatus is exceedingly common in the shell-sands at the limit of the lowest tides. The specimens are always of rather large size, attaining a length of over $2\frac{1}{3}$ inches.

Lastly, I have found in these shell-sands several specimens of a fine *Balanoglossus*, of which I have already given a description in a note addressed to the Academy of Sciences.

The *Balanoglossus* of the island of Herm is very long and of very considerable size. As it is exceedingly soft and its body is always elongated, except towards the posterior extremity, which remains rolled up, I have never succeeded in obtaining a single entire specimen. The drawing which I give (Pl. XI. fig. 1) was made from three separate pieces of the same individual. As it is represented of the natural size, it will be seen that its length was about 14 inches. But I am convinced that some individuals may attain a much greater length, for I have collected pieces of the digestive tube, filled with sand, corresponding to the segment situated beyond the hepatic appendages, which were nearly 16 inches long. The diameter is about $\frac{4}{10}$ inch at the level of the collar.

The conical trunk, $\frac{6}{10}$ inch in length when extended, is of a bright yellow colour. The succeeding or branchio-genital portion of the body, which extends to the hepatic region, is of a deep orange-colour, which passes into dark green at the level of the hepatic diverticula. The green colour is continued beyond the point at which the diverticula disappear; then it is gradually lost, and the last portion of the body, of from 4 to 8 inches in length, is quite colourless.

The collar is $\frac{4}{10}$ inch in length. Its anterior margin

presents some small unequal lobes; its posterior margin is separated from the branchial region only by a slight transverse furrow. The region of the body which succeeds the collar is rather deeply excavated on the dorsal surface; the groove which is observed here, and which is very deep beyond the branchial region, becomes gradually attenuated behind, and disappears a little before the hepatic region, where the body is nearly cylindrical. The branchial region is about $\frac{6}{10}$ inch long. On its dorsal surface it presents an elongated triangle, of which the apex is directed backwards, bounded on each side by a slight groove, and presents in the middle a deeper longitudinal furrow, from which there start laterally some small and very faintly-marked wrinkles, more numerous than the lines of separation of the body-segments.

The hepatic cæca, about forty in number, are simple diverticula of the intestinal wall independent of each other. The posterior region is irregular, more or less lumpy according to the quantity of coarse sand which it contains.

This *Balanoglossus*, like all the species of the same genus, secretes a very abundant mucus from its cutaneous glands. It is well known that the mucus of the *Balanoglossi* possesses a peculiar odour and that this odour varies with the species. Thus a species found by Giard at the Glénans Islands, opposite Concarneau, *B. Robinii*, secretes a mucus which communicates to alcohol a strong odour of rum. In the species from Herm this mucus possesses a very marked and perfectly characteristic odour of iodoform. This odour is extremely persistent; I have recognized traces of it even in specimens of which the spirits had been changed several times.

As this *Balanoglossus* differs in its characters from all the species hitherto described, I have given it the name of *B. sarniensis*, with reference to the locality where I found it. In a note communicated to the Academy of Sciences M. Pouchet has indicated that this *Balanoglossus* was certainly identical with one of the two species found at the Glénans Islands. As these two species have never been described, I have retained for the Herm *Balanoglossus* the name that I gave it. The description and figure which I give will enable the identity of the *Balanoglossus* of the island of Herm to be established hereafter, when the species from Concarneau shall have been studied and described in detail.

Balanoglossus sarniensis appears to exist over the whole extent of the beach, but it does not seem to be very abundant there, for by digging in the sand for two hours (that is to say during the period of low water) I have hardly met with more than two or three specimens. There is nothing, however, to

indicate outwardly the presence of the *Balanoglossus* in the sand, and I have never remarked the pile of sand of which Giard speaks, and which indicates the position of the *Balanoglossi* at the Glénans.

II.—In the *Zosteræ* which extend to the north of the island live some interesting forms, which, however, occur also at Jersey and Guernsey. Some sponges (*Leucosolenia botryoides*, *Isodictya fucorum*) and Compound Ascidia (*Aplidium zostericola*, *Leptoclinum maculosum*, *L. asperum*, *L. gelatinosum*, and *L. sabulosum*, *Didemnum sargassicola*, *Botrylloides*, and *Botryllus*) are common there; small Crustacea (*Hippolyte varians*, *Mysis vulgaris* and *M. chamæleon*, *Gastrosaccus sanctus*, *Cuma Audouini*, and numerous Amphipoda) swarm there. Upon the *Zosteræ* numerous *Lucernariæ* (*L. octoradiata*, Lam.) are attached; I have only observed them at this single station.

III.—Under stones and under the rocks, towards the north and north-west of the island, a very rich fauna lies hidden.

Among the CŒLENTERATA we may cite:—*Sagartia sphyrodeta* and *S. viduata*, Müll., *Aiptasia Couchii* and *Corynactis viridis*, Allm., represented by several varieties which clothe the lower surface of the rocks, in company with *Alcyonium digitatum*, Linn.

Of the SPONGES:—*Sycon ciliatum* and *S. tessellatum*, *Grantia compressa*, *Dictyocylindrus ramosus*, *Hymeniacidon caruncula* and *H. mammeata*, *Halichondria incrustans* and *H. panicea*, and *Isodictya simulans*.

The ECHINODERMATA are represented by *Strongylocentrotus lividus* (pretty common), *Asterias glacialis* (which occurs under nearly every stone), *Ophiothrix fragilis*, *Ophiocoma neglecta*, and *Comatula rosea* (generally distributed species). *Cribrella oculata* and *Asterias rubens* are sometimes found on the sand. *Echinocyamus pusillus*, Flem., is rather common; it also occurs among the *Zostera*. *Cucumaria pentactes* is pretty frequent. In one of the bulbous swellings at the base of the *Laminariæ* I once found a specimen of a Holothurian, which has unfortunately been mislaid; from the description of it, which I have preserved, I think I am not mistaken in referring it to *Psolinus brevis*, Forbes.

The TURBELLARIA are rather abundant:—*Leptoplana tremellaris* and *Prostheceræus vittatus* are frequent; *Polycelis lævigatus* and *Eurylepta cornuta* are sometimes associated with it, but are more rare. Of the Nemerteans I have met with

Lineus longissimus, *Nemertes gracilis*, *Tetrastemma candidum*, and some *Valenciæ*, as at Guernsey.

The POLYCHÆTA are represented by nearly all the Guernsey species. I may particularly mention a very large species of *Lumbriconereis*, over a quarter of an inch broad, of which, unfortunately, I did not obtain the anterior extremity, and which I approximate to the *L. gigantea* described by Quatrefages; and *Polynoë areolata*, Gr., which I did not observe at Guernsey. As to the other species that I have brought from Herm, they are chiefly:—*Polynoë cirrata*, *Sthenelais Edwardsii*, *Eunice Harrassii*, *Marphysa sanguinea*, *Staurocephalus rubrovittatus*, *Lysidice ninetta*, *Lumbriconereis contorta*, *Aonia foliacea*, *Cirratulus Lamarckii*, *Siphonostomum uncinatum*, *Nereis Dumerilii*, *Syllis amica*, *Eulalia clavigera*, *Phyllodoce laminosa*, *Eteone longa*, *Glycera capitata*, &c.

The most interesting CRUSTACEAN of this region is *Alpheus ruber*, Edw., a species which is known to be essentially Mediterranean. Bell describes it in his work from a specimen found in the stomach of a codfish at Falmouth. The *Alpheus* is not very abundant at Herm; I have, however, collected several specimens. Moreover it indicates its presence by the dry sound which it produces by the creaking of the movable joint of its raptorial feet. With *Alpheus ruber* I have found *Stenorhynchus phalangium*, *Inachus dorynchus*, *Pisa Gibbsii* and *P. tetraodon*, *Xantho florida*, *Pilumnus hirtellus*, *Pirimela denticulata*, *Portunus puber*, and *Athanas nitescens*.

Among the MOLLUSCA I must indicate two Cephalopods—*Ommastrephes sagittatus*, Lam., and *Eledone cirrhosa*, Lam.; and two other species which appear also to be peculiar to the island of Herm—*Galeomma Turtonis*, Turt., and *Lima hians*, Gmel.

Unfortunately I could devote only a few hours to my researches in the north of the island of Herm. In the first place I could not go to that island so often as I wished, and further I chiefly explored the shell-sands for the purpose of procuring *Balanoglossi*, of which I wished to possess some specimens which might enable me, after my return to France, to make an anatomical investigation of this interesting type. But the few indications, incomplete as they evidently are, that I am able to give here with regard to the fauna of the island of Herm suffice to show that this locality is one of truly exceptional richness, and that to zoologists fortunate enough to be able to explore it thoroughly it will furnish exceedingly interesting prizes.

The geological constitution of the island of Herm differs

little from that of Guernsey ; in the north the rocks are chiefly granite and present some veins of syenite ; the south of the island is principally formed of gneiss.

SARK.

The little island of Sark is situated 7½ miles east of Guernsey and 11 miles from Jersey. A service of steam-boats runs pretty regularly between Guernsey and Sark during the season.

The island of Sark is exceedingly curious and very remarkable for truly imposing natural beauties. It is a rocky plateau, formed of more or less decomposed syenite, porphyries, and gneiss, with a mean altitude of about 130 feet, terminated on all sides by abrupt coasts, presenting perpendicular cliffs plunging down into the sea. The island consists of two unequal portions, the whole presenting the form of a figure of 8, as they are united by a very narrow isthmus called La Coupée.

The coasts being very high, the sea, in retiring, leaves no shores to be explored except some small beaches, such as those of the Bay of Icart, Terrible Bay, and the Grande Grève. According to the information that I have obtained these beaches present only a few naked rocks and do not shelter any animals, except perhaps a few Sea-Urchins. I devoted all the visits I paid to the island of Sark to the exploration of the Gouliot Caves (*Caverne Frégondée*), which Ansted and Latham, in their book on the Channel Islands, describe as a remarkably rich station as regards its fauna.

These caves are situated on the western coast of the island of Sark, opposite to a small uninhabited island, the island of Brechou or Des Marchands, which is separated from Sark only by a very narrow arm of the sea, called the Gouliot (*Goulet*) ; opposite Brechou the island of Sark presents a small peninsula, the Moye du Gouliot. The rocky mass which forms the Moye is pierced throughout its thickness by a wide excavation in the form of a tunnel, about 100 feet long and from 50 to 70 feet high ; it runs almost exactly in a north and south direction, and thus traverses the Moye du Gouliot perpendicularly. This very picturesque cavern, much larger than the others, is uncovered every tide and presents nothing of interest to the zoologist; its rocks are covered only with *Balani* and dense tufts of *Campanularia flexuosa*. The other caves, situated at a lower level, are exposed only

at spring tides, and they open quite close to the entrance of the preceding one. We penetrate through a fissure between two rocks into a narrow passage, which gradually widens and buries itself in the rock parallel to the direction of the large cavern; this passage constitutes the second cave, upon which the two others open; these are more spacious and go off at right angles, to open upon the sea opposite the island of Brechou.

The last three caves have their walls completely covered with equally numerous and varied animals, which, being only laid dry at very long intervals, for a few hours every fortnight, have attached themselves to the rocks and multiply rapidly, presenting a vigour and a development which one does not find in any other locality. There are, in the first place, *Balani* (*B. balanoides*) which attain very considerable dimensions and upon which are packed together Sponges, Simple and Compound Ascidia, Bryozoa, and Hydraria, belonging to very various species; and the whole forms a thick living layer, in which the abundance of forms, combined with the variation of the brilliant colours, is well fitted to excite the admiration of the naturalists who may visit this incomparably rich station.

The SPONGES are exceedingly abundant in the caves. Bowerbank, who formerly visited them, records a great number of species; but it is certain that the too lavish demands of zoologists must have greatly impoverished this wonderful station. Among the species which I have been able to determine with certainty I will cite:—*Grantia compressa*, *Sycon tessellatum* and *S. ciliatum*, *Leuconia nivea*, Grant, *Leucosolenia contorta*, Bow., and *Leucogypsia Gossei*, Bow. These Calcareous Sponges are very abundant, and the specimens are always of large dimensions. Among the other Sponges I will indicate:—*Caminus osculosus*, Gr., *Geodia zetlandica*, Johnst., *Tethya lyncurium*, Johnst., and *T. Collingsii*, Bow., *Microciona atrosanguinea*, Bow., *Hymeniacidon mammeata*, Bow., *Halichondria panicea*, Johnst., *Isodictya simulans*, Bow., and *Raphyrus Griffithsii*, Bow., besides a great number of undetermined specimens.

The ACTINIÆ are represented by *Actinia equina*, the specimens of which are remarkable for the differences of coloration they present, varying from red to green, brown, yellowish, and pure or yellowish white; by *Actinoloba dianthus*, Ell., and by several species of *Sagartia*, such as *S. venusta*, Gosse, *S. viduata*, Müll., and *S. sphyrodeta*, Gosse. Lastly, *Corynactis viridis* is very abundant in the last two caves, and presents several varieties, the most common of which corre-

spond to those which Gosse designates by the names of *C. smaragdina*, *C. rhodoprasina*, *C. chrysochlorina*, and *C. corallina*, according to the predominant colour.

In the third cave I have also collected several specimens of *Alcyonium digitatum*. In this same cave are found *Tubulariæ* (*T. indivisa*, Hincks), which cover its roof with their dense tufts.

The Simple Ascidia are very generally diffused. *Cynthia rustica* attains a very large size; we find further *Ascidia producta*, *Ascidiella aspersa* and *A. scabra*, *Cynthia sulcatula*, and *Molgula arenosa*, Ald.

Upon the tunics of these different species are attached numerous Compound Ascidia, such as *Leptoclinum asperum* and *L. durum*, *Amaroucium albicans* and *A. Nordmanni*; Bryozoa, namely *Crisia cornuta* and *C. denticulata*, Lam., *Cellepora pumicosa*, Lam., *Lepralia foliacea*, Ell. & Sol., *Scrupocellaria scrupea*, Busk, *Mucronella Peachii*, Johnst., *Membranipora pilosa*, Linn., &c., together with numerous Hydroids (*Campanulariæ*, *Sertulariæ*, *Plumulariæ*).

Among the Ascidians live numerous species of Vermes and Crustacea. The Annelides are especially represented by *Nereis cultrifera* and *N. Dumerilii*, *Syllis amica* and *S. divaricata*, *Trypanosyllis Krohnii*, Grube, common *Serpulæ* and *Vermiliæ*, and a species of *Filigrana*.

The Crustacea almost all belong to the Isopoda and Amphipoda. Among the latter I will cite *Montagua monoculoides* and *M. marina*, *Atylus bispinosus*, *Anonyx Edwardsii*, and *Microdeutopus Websterii*, Sp. B.; *Nicea Lubbockiana*, *Aora gracilis*, *Podocerus capillatus*, *Exunguia stillipes*, Nordm.; and *Nœnia tuberculosa*, Sp. B. Among the Isopoda :—*Leptochelia Edwardsii*, *Paratanais forcipatus*, *Apseudes talpa*, *Jæra Nordmanni*, *Janira maculosa*, and, finally, a new form, which I described last year in the 'Annales des Sciences Naturelles' under the name of *Jæropsis brevicornis*, Kœhl.

I will further indicate *Caprella hystrix*, Kröy., *Pycnogonum littorale*, and *Ammothea longipes*.

I have already noticed the presence in the caves of *Æpophilus Bonnairei* and its larva.

As to the Mollusca, they are represented by a few not very interesting forms, such as *Anomia ephippium*, Linn., *Modiolaria marmorata*, Forbes, and *M. discors*, Linn., *Chiton discrepans*, Br., and *C. lævis*, Mont., *Mytilus edulis*, Linn., var. *angulata*, and *Doris tuberculata*, Cuv.

List of the Marine Invertebrata collected at the Anglo-Norman Islands in 1884–85*.

Sponges.

Sycon ciliatum, *Häck.* J., G., H., S.
—— tessellatum, *Bow.* G., H., S.
Grantia compressa, *Flem.* J., G., H., S.
—— ensata, *Bow.* G.
Leuconia nivea, *Gr.* J., S.
Leucosolenia contorta, *Bow.* S.
—— botrylloides, *Bow.* J., G., H.
—— lacunosa, *Bow.* G.
Leucogypsia Gossei, *Bow.* S.
Geodia zetlandica, *Johnst.* S.
Caminus osculosus, *Grube.* J., S.
Polymastia mammillaris, *Bow.* G.; *d.*
Tethya lyncurium, *Johnst.* J., S.
—— Collingsii, *Bow.* S.
Dictyocylindrus ramosus, *Bow.* J., G.
Microciona armata, *Bow.* J., G.; *d.*
—— atrosanguinea, *Bow.* S.
Hymeniacidon caruncula, *Bow.* J., G., H.
—— mammeata, *Bow.* J., G.
—— armatura, *Bow.* J., G., H.
—— celata, *Bow.* J., G.
Halichondria panicea, *Johnst.* J., G., H., S.
—— incrustans, *Johnst.* G., H.
Isodictya cinerea, *Bow.* J., G.
—— densa, *Bow.* G.; *d.*
—— simulans, *Bow.* J., G., H., S.
—— fucorum, *Bow.* J., G., H.
—— infundibuliformis, *Bow.* G.; *d.*
—— parasitica, *Bow.* J., G.
Chalina cervicornis, *Bow.* G.
Dysidea fragilis (?), *Johnst.* J.
Verongia rosea (?), *Barrois.* J.
Raphyrus Griffithsii, *Bow.* S.
Oplitospongia papillata, *Bow.* G.
(And many still undetermined species.)

Cœlenterata.

Aiptasia Couchii, *Gosse.* G., H.
Actinoloba dianthus, *Ell.* S.
Actinia equina, *Linn.* J., G., H., S.
Anemonia sulcata, *Penn.* J., G., H.
Tealia crassicornis, *Thomps.* J., G., H.
Bunodes gemmacea, *Gosse.* J., G., H.
Sagartia parasitica, *Couch.* J., G., H.
—— bellis, *Gosse.* J., G., H.
—— venusta, *Gosse.* S.
—— viduata, *Müll.* S.
—— sphyrodeta, *Gosse.* G., S.
—— ——, var. candida. J.
Sagartia troglodytes, *Gosse.* J., G., H.
Adamsia palliata, *Johnst.* J.; *d.*
Edwardsia callimorpha, *Gosse.* J., G.
—— Harrassii, *Quatref.* H.
Corynactis viridis, *Allm.* H., S.
—— ——, var. smaragdina.
—— ——, var. rhodoprasina.
—— ——, var. chrysochlorina.
—— ——, var. corallina.
Peachia undata, *Gosse.* H.
Caryophyllia Smithii, *Stokes.* G., H.
Alcyonium digitatum, *Linn.* H., S.
Lucernaria octoradiata, *Lam.* J., H.

* The letters J., G., H., S. denote that the species indicated have been found in the islands of Jersey, Guernsey, Herm, or Sark. I mark with the letter *d* the species which are obtained only by the dredge.

ECHINODERMATA.

Strongylocentrotus lividus, *Br.* J. (*d*), G., H.
Sphærechinus granularis, *Ag.* J.; *d.*
Spatangus purpureus, *Müll.* H.
Echinocardium cordatum, *Penn.* G.
—— flavescens, *Müll.* H.
Echinocyamus pusillus, *Flem.* H.
Asteriscus verruculatus, *Retz.* J., G., H.
Asterias glacialis, *Müll.* J., G., H.
—— rubens, *Linn.* J. (*d*), G., H.
Solaster papposus, *Retz.* J.; *d.*
Palmipes membranaceus, *Retz.* J.; *d.*
Luidia fragilissima, *Forbes.* G.; *d.*
Ophiothrix fragilis, *Müll.* J., G., H.
Ophiocoma neglecta, *Johnst.* J., G., H.
Ophiura albida, *Forbes.* J.; *d.*
—— texturata, *Lam.* J.; *d.*
Antedon rosaceus, *Link.* J., G., H.
Cucumaria pentactes, *Gunn.* G., H.
—— frondosa, *Müll.* G.
Psolinus brevis, *Forbes.* H.
Synapta inhærens, *Düb. & K.* J., G., H.

VERMES.

Leptoplana tremellaris, *Œrst.* J., G., H.
Prostheceræus vittatus, *Lang.* J., G., H.
Oligocladus sanguinolentus, *Quatref.* J.
Stylochoplana maculata, *Stimps.* J.
Polycelis lævigatus, *Quatref.* J., H.
Proceros argus, *Quatref.* G.
Eurylepta cornuta, *Müll.* G., H.
Lineus longissimus, *Sim.* J., G., H.
—— gesserensis, *Johnst.* J.
Valencia splendida, *Quatref.* J., G., H.
—— longirostris, *Quatref.* J., G., H.
—— ornata, *Quatref.* J., G., H.
Amphiporus lactifloreus, *M. Sert.* J.
Nemertes gracilis, *Quatref.* J., G.
Polia filum, *Quatref.* J.
—— sanguirubra, *Quatref.* J.
Cerebratulus bilineatus, *Ren.* J.
Tetrastemma candidum, *Müll.* J., G., H.
Avenardia Priei, *Giard.* H.

Phascolosoma elongatum, *Kef.* J., G., H.
—— margaritaceum, *Sars.* J., G., H.

Aphrodite aculeata, *Linn.* J.; *d.*
—— hystrix, *Aud. & Edw.* J.; *d.*
Polynoë cirrata, *Müll.* J., G., H.
—— squamata, *Sav.* J., G.
—— areolata, *Grube.* H.
Lagisca propinqua, *Malmgr.* J., G.
Harmothoë Malmgreni, *Lank.* G., H.
Sthenelais Edwardsii, *Quatref.* J., G., H.
Eunice Harrassii, *Aud. & Edw.* J., G., H.
—— Belli, *Aud. & Edw.* J.
Marphysa sanguinea, *Aud. & Edw.* J., G., H.
Staurocephalus rubrovittatus, *Gr.* G., H.
Lysidice ninetta, *Aud. & Edw.* J., G., H.
Lumbriconereis contorta, *Quatref.* J., G., H.
—— humilis, *Quatref.* J., G.
—— gigantea (?), *Quatref.* H.
Nephthys Hombergii, *Aud. & Edw.* J., G., H.
—— scolopendroides, *D. Chi.* J.
—— longisetosa, *Œrst.* J.
Aonia foliacea, *Aud. & Edw.* J., H.
Cirratulus Lamarckii, *Aud. & Edw.* J., G., H.
Chloræma Dujardinii, *Quatref.* G.
Siphonostomum uncinatum, *Aud. & Edw.* J., G., H.

Nereis cultrifera, *Grube*. J., G., H.
—— Dumerilii, *Aud. & Edw.* J., G., H.
—— Marionii, *Aud. & Edw.* J.
—— falsa, *Quatref.* G.
—— irrorata, *Malmgr.* J.
Nereilepas lobulatus, *Quatref.* J.
Leptonereis Vaillanti, *St.-Jos.* J.
Syllis amica, *Quatref.* J., G., H., S.
—— divaricata, *Kef.* J., G., S.
Grubea fusifera, *Quatref.* J.
Claparedia filigera, *Quatref.* J.
Trypanosyllis Krohnii, *Gr.* S.
Eulalia clavigera, *Aud. & Edw.* J., G., H.
Phyllodoce laminosa, *Sav.* J., G., H.
Eteone longa, *Sav.* J., G., H.
Glycera capitata, *Œrst.* G., H.
—— lapidum, *Quatref.* J.
—— alba, *Rathke.* H.
Chætopterus Valencinii, *Quatref.* G., H.
—— Quatrefagesii, *Jourd.* J., G.
Clymene lumbricoides, *Aud. & Edw.* J., G., H.
Leiocephalus coronatus, *Quatref.* H.
Arenia cruenta, *Quatref.* H.
—— fragilis, *Quatref.* H.
Petaloproctus terricola, *Quatref.* J., G.
Arenicola piscatorum, *Cuv.* J., G., H.
—— ecaudata, *Johnst.* J., G., H.
Ophelia bicornis, *Sav.* J.
Ammotrypane œstroïdes, *Rathke.* H.
Aricia Cuvieri, *Aud. & Edw.* J., G., H.
Leucodore ciliata, *Johnst.* J.
Terebella conchilega, *Pall.* J., G., H.
—— prudens, *Cuv.* J.
Terebella nebulosa, *Mont.* J., G.
—— Montagui, *Quatref.* G.
Sabella pavonina, *Sav.* J., G., H.
—— verticillata, *Quatref.* J., G.
—— arenilega, *Quatref.* J., G., H.
Protula protensa, *Grube.* J., G.
Filigrana, sp. J.
Salmacina Dysteri, *Quatref.* J.; *d.*
Vermilia conigera, *Quatref.* J., G.
—— tricuspis, *Quatref.* J., G.
Serpula fascicularis, *Lam.* J., G.
Spirorbis communis, *Flem.* J., G., H.

Argiope capsula.

Crisia denticulata, *Lam.* J., G., S.
—— cornuta, *Linn.* J., G., S.
Bugula avicularia, *Linn.* J., G.
Bicellaria ciliata, *Linn.* J.
Scrupocellaria scrupea, *Busk.* J., G., S.
—— reptans, *Linn.* J.
Membranipora pilosa, *Linn.* J., G., S.
—— membranacea, *Linn.* J., G., H., S.
—— lineata, *Linn.* J.
Cellepora pumicosa, *Linn.* J., S.
Lepralia foliacea, *Ell. & Sol.* J., G., S.
Mucronella Peachii, *Johnst.* J., G., H., S.
—— coccinea, *Hincks.* J.
—— variolosa, *Johnst.* J.
Flustrella hispida, *Fabr.* J.
Bowerbankia imbricata, *Ad.* J., G., H.
Smittia reticulata, *J. Mac.* J.
Cribrilina punctata, *Hass.* J.
Pedicellina cernua, *Pall.* J., G.
Loxosoma phascolosomatum, *Vogt.* J., G., H.

Ascidia.

Ciona intestinalis, *Linn.* J., G.
—— ——, var. canina. J., G.
—— ——, var. fascicularis. J., G.
Ascidia mentula, *Müll.* J., G., H.
—— producta, *Hanc.* J., G.
Ascidiella aspersa, *Müll.* J., G., H.
—— scabra, *Müll.* J.
Polycarpa glomerata, *Ald.* J., G.
Cynthia rustica, *Müll.* J., G., H., S.
—— granulata, *Ald.* J., S.
—— sulcatula, *Ald.* J., G., H.
Molgula arenosa, *Ald.* S.
—— socialis, *Ald.* G.
Anurella roscovita, *Lac.* J.

Ctenicella Lanceplaini, *Lac.* J.
Clavelina lepadiformis, *Wiegm.* J., G.
Perophora Listeri, *Müll.* J., G.
Aplidium zostericola, *Giard.* J., G., H.
Amaroucium Nordmanni, *Edw.* J., G., S.
—— albicans, *Edw.* J., G., S.
—— proliferum, *Edw.* J., G.
Fragarium elegans, *Giard.* J., G.
Morchellium argus, *Giard.* J., G.
Leptoclinum maculosum, *Edw.* J., G.
—— asperum, *Edw* J., G., H.
—— durum, *Edw.* J., G.
—— Lacazii, *Giard.* G.
—— fulgidum, *Edw.* J., G., H.
Leptoclinum gelatinosum, *Edw.* J., G.
—— sabulosum, *Giard.* J., G., H.
Didemnum sargassicola, *Giard.* J., G., H.
Diplosoma Kœhleri, *Lah.* J., G.
Botrylloides rotifera, *Edw.* J., G.
—— rubrum, *Edw.* J., G.
Botryllus Schlosseri, *Sav.* J., G., H.
—— ——, var. adonis, *Giard.* J., G.
—— pruinosus, *Giard.* J.
—— smaragdus, *Giard.* J., G.
—— violaceus, *Edw.* J., G.
—— aurolineatus, *Giard.* J., G.
—— rubigo, *Giard.* J.
—— morio, *Giard.* J.

Crustacea.

Stenorhynchus phalangium, *Edw.* J., G., H.
—— tenuirostris, *Bell.* J., G.
—— ægyptius, *Edw.* J.
Achæus Cranchii, *Leach.* J.
Inachus dorynchus, *Leach.* J., G., H.
—— dorsettensis, *Leach.* J.
—— leptochirus, *Leach.* J.; *d.*
Pisa Gibbsii, *Leach.* J., G., H.
—— tetraodon, *Leach.* J., G.
Hyas coarctatus, *Leach.* J.; *d.*
—— araneus, *Leach.* J.; *d.*
Maia squinado, *Leach.* J., G.
Eurynome aspera, *Leach.* J.; *d.*
Xantho florida, *Leach.* J., G., H.
—— rivulosa, *Edw.* J., G.
Pilumnus hirtellus, *Leach.* J., G., H.
Cancer pagurus, *Bell.* J., G.
Pirimela denticulata, *Leach.* J., G., H.
Carcinus mænas, *Leach.* J., G.
Ebalia Pennantii, *Leach.* J.; *d.*
—— Bryerii, *Leach.* J.; *d.*
—— Cranchii, *Leach.* J.; *d.*
Portunus puber, *Leach.* J., G., H.
—— corrugatus, *Leach.* J., G.
—— arcuatus, *Leach.* J., G.
—— holsatus, *Fabr.* J.; *d.*
—— pusillus, *Leach.* J.
—— depurator, *Leach.* J., G.
—— marmoreus, *Leach.* J.
Portumnus variegatus, *Leach.* J.; *d.*
Pinnotheres pisum, *Latr.* J., G.
Dromia vulgaris, *Edw.* J.; *d.*
Corystes cassivelaunus, *Penn.* J., G., H.
Porcellana platycheles, *Lam.* J., G.
—— longicornis, *Edw.* J., G., H.
Thia polita, *Leach.* J., H.
Gebia deltura, *Leach.* J., G., H.
Callianassa subterranea, *Leach.* J.
Axius stirhynchus, *Leach.* J., G., H.
Pagurus Bernhardus, *Fabr.* J., G.
—— cuanensis, *Thomps.* J.; *d.*
—— Hyndmanni, *Thomps.* J.; *d.*
Eupagurus Prideauxii, *Leach.* J.; *d.*
Homarus vulgaris, *Edw.* J. G.
Palinurus vulgaris, *Latr.* J. G.
Scyllarus arctus, *Rœm.* G.; *d.*
Galathea squamifera, *Leach.* J., G.
—— strigosa, *Fabr.* J.
—— Andrewsii, *Norm.* J.; *d.*
—— nexa, *Embl.* J.; *d.*
Palæmon serratus, *Fabr.* J., G.
—— squilla, *Fabr.* J., G.
—— varians, *Leach.* G.
Crangon vulgaris, *Fabr.* J., G.
—— fasciatus, *Risso.* J., G.
—— sculptus, *Bell.* J.
—— bispinosus, *Westw.* J.
—— trispinosus, *Hailst.* J.
Nika edulis, *Risso.* J.
Pandalus annulicornis, *Leach.* J.; *d.*
Athanas nitescens, *Leach.* J., G., H.

Hippolyte varians, *Leach.* J., G.
—— Cranchii, *Leach.* J.; *d.*
—— viridis, *Edw.* J., G.
Lismata seticaudata, *Risso.* J.
Alpheus ruber, *Edw.* H.
Mysis chamæleon, *Thomps.* J., G.
—— vulgaris, *Thomps.* J., G.
—— Griffithsiæ, *Bell.* J.
Themisto brevispinosus, *Goods.* J., G.
Cynthia Flemingii, *Goods.* J.
Thysanopoda Couchii, *Bell.* J.
Cuma Edwardsii, *Bell.* J.
Sphinoë serrata, *Norm.* J.
—— trispinosa, *Goods.* J.
Gastrosaccus sanctus, *Ben.* J., G., H.
Squilla Desmarestii, *Risso.* J.

Talitrus locusta, *Latr.* J., G., H.
Orchestia mediterranea, *Costa.* J., G.
—— littorea, *Leach.* J., G.
Nicea Lubbockiana, *Sp. B.* J., S.
Montagua monoculoides, *Sp. B.* J., G., S.
—— marina, *Sp. B.* J., G., S.
Ampelisca Gaimardii, *Kröy.* J.
Anonyx Edwardsii, *Kröy.* J., G., H.
—— longipes, *Sp. B.* J.
Dexamine spinosa, *Leach.* J., G.
—— vedlemensis, *Sp. B.* J.
Acanthonotus Oweni, *Sp. B.* J.
Atylus Swammerdamii, *Sp. B.* J., G.
—— bispinosus, *Sp. B.* J., G., H.
Pherusa fucicola, *Leach.* J., G., H.
—— bicuspis, *Edw.* J.
Iphimedia obesa, *Rathke.* J.
Leucothoë articulosa, *Leach.* J., G.
Aora gracilis, *Sp. B.* J., S.
Gammarella longicornis, *Kœhl.* J.
Melita palmata, *Leach.* J., G.
Mœra grossimana, *Leach.* J., G., H.
Eythræus erythrophthalmus, *Sp. B.* J.
Amathilla Sabini, *Leach.* J.
Gammarus marinus, *Leach.* J., G. H.
—— locusta, *Fabr.* J., G., H.
—— campylops, *Leach.* J.
—— brevicaudatus, *Edw.* J.
Amphithoë littorina, *Sp. B.* J., G.
—— gammaroides, *Sp. B.* J., G.
Podocerus falcatus, *Sp. B.* J., G., H., S.
Podocerus capillatus, *Rathke.* J., S.
Microdeutopus gryllotalpa, *Costa.* J., G., S.
—— Websterii, *Sp. B.* J., S.
Corophium longicorne, *Lath.* J., G.
Cerapus punctatus, *Edw.* J.
Siphonœcetes typicus, *Kröy.* J.
Exunguia stillipes, *Nordm.* S.
Nœnia tuberculosa, *Sp. B.* S.
Chelura terebrans, *Philip.* J.
Spheroma serratum, *Fabr.* J., G., H.
—— curtum, *Leach.* J.
—— Prideauxianum, *Leach.* J., G., H.
Dynamene viridis, *Leach.* J., G.
—— Montagui, *Leach.* J., G.
Cymodoce truncata, *Leach.* J. G.
Næsa bidentata, *Leach.* J. G.
Idotea tricuspidata, *Desm.* J., G., H.
—— pelagica, *Leach.* J.
—— linearis, *L.* J., G., H.
—— acuminata, *Leach.* J., G.
—— appendiculata, *Risso.* J.
—— emarginata, *Fabr.* J.
Limnoria lignorum, *Rathke.* J.
Janira maculosa, *Leach.* J., G., H.
Cirolana Cranchii, *Leach.* J.; *d.*
Conilera cylindracea, *Mont.*, var. punctata. J.; *d.*
Ligia oceanica, *Fabr.* J.
Jæra Nordmanni, *Rathke.* J., G., S.
Jæropsis brevicornis, *Kœhl.* S.
Bopyrus squillarum, *Latr.* J., G., H.
Anilocra mediterranea, *Leach.* J., G.
Paranthura Costana, *Sp. B.* J., G., H.
Apseudes talpa, *Leach.* J., S.
Tanais vittatus, *Liljb.* J., G., S.
Leptochelia Edwardsii, *Kr.* J., G., S.
Paratanais forcipatus, *Liljb.* J., G.
Anceus maxillaris, *Mont.* J., G.
Praniza cærulea, *Desm.* J., G.

Protella phasma, *Sp. B.* J.
Caprella hystrix, *Kr.* J., G., S.
—— linearis, *Edw.* J., G.
—— acanthifera, *Leach.* J.
Nebalia Geoffroyi, *Edw.* J., G., H.

Other Arthropoda.

Æpus Robinii, *Lab.* J.
Ochthebius Lejolisi, *Leach.* J.
Philhydrus melanocephalus, *Oliv.* G.
Æpophilus Bonnairei, *Sign.* J., S.
Corixa, sp. G.
Larvæ of Diptera. G.
Ammothea longipes, *Hodg.* J., G., S.
Pycnogonum littorale, *Ström.* J., G.
Halacarus, sp. ?

Mollusca *.

Doris flammea, *Ald. & Hanc.* J., G.
—— tuberculata, *Ald. & Hanc.* J., G., S.
—— Johnstoni, *Ald. & Hanc.* J., G.
Eolis Cuvieri, *Lam.* J., G.
Triopa claviger, *Müll.* J., G.
Pleurobranchus membranaceus, *Mont.* J., G., H.
Eledone cirrhosa, *Lam.* H.
Ommastrephes sagittatus, *Lam.* H.

Chordata.

Balanoglossus sarniensis, *Kœhl.* H.
Amphioxus lanceolatus, *Yarr.* H.

EXPLANATION OF PLATE XI.

Fig. 1. *Balanoglossus sarniensis*, drawn from three fragments forming a complete individual, preserved in spirits.
Fig. 2. *Æpophilus Bonnairei*, larva, × 22.
Fig. 3. One of the valves of the sheath of the female genital armature, × 38.
Fig. 4. Abdomen of the male seen from above, × 24.
Fig. 5. Leg of larva, × 28.
Fig. 6. Adult female, dorsal surface, × 12.
Fig. 7. Adult female, ventral surface, × 12.
Fig. 8. Rostrum of adult, × 30.
Fig. 9. Rostrum of larva, × 30.

XXXVI.—*Note on* Pachymetopon *and the Australian Species of* Pimelepterus. By Dr. A. Günther, Keeper of the Zoological Department, British Museum.

The type specimen of *Pachymetopon grande* was transferred to the British Museum when the collection of the Zoological Society was broken up. Some time after the publication of the first description of the fish (Günth. Fish. i. p. 424) I ascertained from the MS. catalogue of the society that the specimen was originally obtained by the late Sir A. Smith at the Cape of Good Hope. No other individual has come under my notice since; but I have no doubt that naturalists residing at the Cape would have no difficulty in obtaining other examples. Fresh specimens preserved in spirits and skeletons of this fish are desiderata in every museum.

The fish described by Steindachner as *Pachymetopon Guentheri* (Sitzungsber. Wien. Ak. lx. 1870, p. 135) is also from the Cape of Good Hope, and probably not specifically distinct from *P. grande*. The characters in which this second species is considered to differ are the proportionate length of the head

* To be added to M. Duprey's lists.

and the number of scales in the lateral line. But it should be remembered that the type specimen of *P. grande* is stuffed, and that the arrangement of the scales is not so regular that the number of scales in the lateral line would correspond to that of the transverse series above the line. The latter are more numerous and were counted by me; Steindachner's statement seems to refer to the former. Also difference in size and age should be taken into consideration; but Steindachner has omitted to state the size of his specimen.

A stuffed specimen in excellent condition, 30 inches long, which we received from the New South Wales Court of the Fisheries Exhibition in 1883 under the name of *Pachymetopon grande*, was of particular interest, as it led to the discovery that the fishes which Australian ichthyologists introduced into their lists as *Pachymetopon* are nothing but species of *Pimelepterus*, a genus which is entirely left out of their ichthyological fauna. Thus the specimen from the Sydney Museum is a species closely allied to *Pimelepterus fuscus*, from which, however, it may be distinguished by the larger scales on the back (fewer longitudinal series—nine, instead of eleven or twelve) and by the shorter horizontal roots of the teeth. To this species, then, probably belongs the fish enumerated by Mr. Macleay under the name of *Pachymetopon grande* (Cat. Austr. Fish. i. p. 106). Finally, the *Pachymetopon squamosum* of the same author and Dr. Alleyne (Proc. Linn. Soc. N. S. Wales, i. p. 275, pl. ix. fig. 1) is the common *Pimelepterus cinerascens* of Forskål or *Pimelepterus tahmel* of Rüppell, which ranges from the Red Sea, through the Indian Ocean, into the Pacific, and the occurrence of which on the coast of New Guinea has been already recorded by Cuvier and Valenciennes (Hist. Nat. Poiss. vol. vii. p. 270).

The diagnosis of the *Pimelepterus* from Port Jackson is as follows:—

Pimelepterus sydneyanus.

D. $\frac{11}{11}$. A. $\frac{3}{11}$. L. lat. 67. L. transv. $\frac{9}{18}$*.

The height of the body is nearly one third of the total length (without caudal), the length of the head two ninths. Width of the interorbital space but little less than one half of the length of the head. The soft dorsal fin and anal are a little lower than the spinous. Pectoral as long as the head without snout. The horizontal root of the incisors is not much longer than the vertical part. Coloration uniform.

Port Jackson.

* The formula given by Macleay for his *Pachymetopon* is simply copied from my description and transferred to the fish misnamed by him.

XXXVII.—*Supplement to the Descriptions of Mr. J. Bracebridge Wilson's Australian Sponges.* By H. J. CARTER, F.R.S. &c.

[Plate X.]

[Continued from p. 290.]

Order III. PSAMMONEMATA.

STELOSPONGOS, Sdt.

I have already gone into the history of this genus under the head of "*Stelospongus lævis*, Hyatt" ('Annals,' 1885, vol. xv. p. 303), and I should not have returned to the subject had I not found, on comparing the whole of the specimens in Mr. Wilson's several collections, that I had confused, in my description, two forms so very much alike externally that without many examples of each, and thus sufficient material for the destruction caused by sectioning, I should not have been able to contrast their characters satisfactorily for distinction. Let us now see what these are.

In *Stelospongus lævis* the keratose skeletal structure not only predominates in quantity over the sarcodic, but is peculiarly abundant, presenting in a vertical section of the dried and washed-out specimen a radio-floral arrangement of the main bundles of the fibre, by their curving upwards and outwards from the lower part of the axis to the circumference, being bound together on their way by a dense network of lateral or smaller fibre. In the other species, for which I propose the name of "*Stelospongus cribrocrusta*," it is the opposite, viz. the sarcodic greatly predominates over the keratose structure, which, on the other hand, is very scanty, presenting itself only under the form of a scattered fibroreticulation, in which the meshes appear from their width to be almost absent in the centre, while they thicken by becoming smaller towards the circumference, and especially in the stem, where this structure is most required for general support.

In *Stelospongus lævis* the surface consists of a thin incrustation uniformly studded over with little tufts of fibres, which project beyond the dermal sarcode and are the circumferential terminations of the radiating bundles of the interior; these tufts may be separate, or, becoming compressed and extended laterally, so as to meet each other, may give rise to a poly-

gonal or honeycomb appearance on the surface. In *S. cribrocrusta* it consists of a thick incrustation of foreign material, which externally presents a polygonal lattice-like reticulation in slight relief, whose interstices in the perfect condition are diaphragmed with sieve-like pore-structure, which, in the worn state, is replaced by a single circular hole; while internally this crust is attached to the circumferential portion of the subjacent fibrous skeleton by a few straight, single, delicate filaments, which for the most part do not penetrate the crust sufficiently to appear on the surface; indeed, so slight is this attachment that on desiccation the crust cracks up, through partial collapse of the sarcodic interior, and thus separates itself from the filaments of the subjacent fibre.

In *Stelospongus lævis* the abundance of keratose skeletal fibre enables it under desiccation to retain its original form, while in *S. cribrocrusta* there is more or less corrugation and breaking-up of the crust, owing, as just stated, to the shrinking of the sarcode internally.

Thus the keratose fibro-skeletal structure of *S. cribrocrusta* is so delicate and so scanty that it could hardly sustain the wash of the sea-shore waves without going to pieces, while that of *S. lævis* is so firm and dense that the utmost washing of the waves could hardly destroy its structure; hence thelatter has been found in great numbers on the South-Australian shores, as our museums and private collections testify; while I have never seen a specimen of *S. cribrocrusta* except in Mr. Wilson's collection, where the specimens were transferred from the dredge directly to a vessel containing methylated spirit and water for preservation.

The spirit-preserved specimen described and illustrated by Bowerbank under the name of "*Halispongia choanoides*," so named from its supposed identity with the fossil "*Choanites Kœnigii*" (Proc. Zool. Soc. 1872, p. 123, pl. vi.), seems to have been a variety of *S. cribrocrusta*; but if this should not be the case, the illustrations of the "keratose sponge" from South Australia, which he described from spirit-preserved specimens in the British Museum in 1841 ('Annals,' vol. vii. p. 129, pl. iii.), are so undoubtedly! and to those, especially that of the dermal crust in its "perfect state" (fig. 7), I would refer the reader, for it is, as Dr. Bowerbank has stated of all the rest, "beautifully and faithfully represented."

It is strange that, in his description of *Halispongia choanoides*, Bowerbank should have made no allusion to this "keratose sponge," which is so typical of *S. cribrocrusta* that had he proposed a name for it, I should not have had to introduce the one above mentioned; for the characters of

Stelospongus lævis and *S. cribrocrusta* are so remarkably different that the two cannot come under the same designation, while those of *Halispongia choanoides* and *Stelospongus cribrocrusta* are remarkably alike.

At the same time Dr. Bowerbank, in 1872 (*l. c.*), evidently connects *Halispongia choanoides* with *Stelospongus lævis*, when at p. 123 he says, " the skeletons of what are apparently various species of this genus are very common in collections from Australia," by which he probably meant those of *S. lævis*, to which I have alluded as being so durable that their skeletal structure survives the ordeal of the waves in which *S. cribrocrusta* would go to pieces.

Again, Hyatt states, with reference to the typical structure of the fibrous skeleton in " *Stelospongus*," viz. the radiating primary bundles (*op. et loc. cit.* p. 529), that " there are none of these, properly speaking, in some other species, but only closely connected sheets of parallel primary fibres; . . . these lead into the genus *Spongelia*, between which and this genus no definite and constant differences, applicable to all the species without reservation, have been found in the skeleton." How far this may apply to *S. cribrocrusta* I cannot say, for the other species of *Stelospongus* which I have described from " Port Phillip Heads " (*op. et loc. cit.*), viz. *S. flabelliformis*, *S. latus*, and provisionally *S. tuberculatus*, present respectively the crust of *S. cribrocrusta*, but with much more keratose fibre—especially *S. flabelliformis*, which, but for the difference in consistence, form, and structure of the fibre, might *externally*, on account of the crusts being so much alike, be viewed as a specimen of *Coscinoderma*; while, on the other hand, the density of the keratose structure and its sand-bearing fibre internally allies it to *Stelospongus lævis*.

Under these circumstances I shall give the following description of *Stelospongus cribrocrusta*, and leave others to form their opinion of it afterwards.

Stelospongus cribrocrusta, n. sp.

General form pear-shaped (the same as that of *S. lævis*). Colour grey. Surface even, composed of foreign material so arranged as to present a uniform polygonal reticulation in slight relief, whose interstices are diaphragmed by the pore-areas, which consist of a much smaller reticulation formed of sarcode, also charged with foreign material. Vents for the most part very large, single or in plurality, on the summit of the sponge, more or less projected on conical eminences of the general structure, or on a level with the arenaceous crust that extends up to their margin, which is not fringed but even.

Internal structure sarcodic, much more than kerato-fibrous, the latter consisting of a loosely reticulated fabric, whose interstices are so wide and the fibres so small and scanty in the centre of the sponge that it is hardly noticeable, thickening in structure and consistence towards the circumference, and especially in the stem. Fibre stiff, of a clear amber-colour and transparency, here and there cored with grains of quartz-sand, supporting on the circumference the crust above mentioned, which is very thick, consisting of a reticulated dermo-fibrous sarcodic structure, densely charged with foreign material, presenting *externally* the kind of " surface " above described, which is penetrated on the inner side by fine straight filaments of the skeletal fabric, the latter (still further in) supporting the sarcodic parenchyma, which is largely traversed by the canals of the excretory system that empty themselves into a cylindrical, central, cloacal, tubular cavity, which terminates in the single vent mentioned, or in plurality, when the vents also are more than one in number. Size variable, the largest specimen about 5 in. long, one third of which is stem; head 2 in. in its greatest diameter; stem, which expands upwards into the head and downwards into the root, $\frac{1}{2}$ in. in diameter in its narrowest part.

Loc. Port Phillip Heads and Port Western.

Obs. When a vertical section of this species is made the great cylindrical, cloacal canal of the centre, which in *Stelospongus lævis* is in the midst of dense fibrous keratose structure, is found to be in the midst of almost entirely parenchymatous sarcode, for the skeletal fibre here is so scanty that the greater part of the body appears to be composed of sarcode, so that in this matter alone *S. cribrocrusta* and *S. lævis* are totally different; yet it sometimes seems to me possible that they may be the extreme structures of the same form and genus respectively, hence the same generic name has been used for both.

Hircinia flagelliformis, n. sp. (dry).

Erect, cauliform, cylindrical, round, solid, long stems of different lengths, growing together and branching scantily from an expanded base of the same structure; round at the free end and decreasing in size backwards so gradually that one 28 in. long may be only $\frac{1}{2}$ in. in diameter at the base and $\frac{1}{4}$ in. at the other extremity. Consistence firm and stiff, especially when dry. Colour amber-brown. Surface uniformly presenting small conuli arranged in more or less broken sinuous lines intertympanized by homogeneous fine sarcode charged with small epithelial cells supported by the subjacent keratose

structure. Pores not seen. Vents numerous, scattered over the surface irregularly throughout the branch. Skeletal support consisting of densely reticulated, stiff, short-jointed fibre of two kinds, viz. sand-cored or main, whose branches end in the conuli on the surface, and transparent or lateral, interuniting the sand-cored filaments, the latter diminishing in size with the increase of the reticulation. Largest specimen, which consists of a group of twelve stalks of different lengths, varying from $2\frac{1}{2}$ to 28 in. in length and under $\frac{1}{2}$ in. in diameter, all growing up out of the same expanded base.

Loc. Port Western.

Obs. This species in form is very like that from the West Indies, which I have described under the name of "*Aplysina longissima*" ('Annals,' 1882, vol. ix. p. 271), whose structure and characters were so ill-defined, that at the time I was doubtful whether to call it an *Aplysina* or "*Hircinia*," so it is just possible that the two are the same. The soft fibro-reticulated dermal structure which characterizes most sponges of this kind in Mr. Wilson's collection is absent in *Hircinia flagelliformis*, in which, instead of being thick and opaque when dry, it is thin, transparent, and homogeneous.

Hircinia (*Spongelia*) *rectilinea*, Hyatt.

Hircinia (*Spongelia*) *rectilinea*, Hyatt, Revision of N. American Poriferæ, p. 537, pl. xvii. no. 13.

Vase-shaped, cylindrical, stipitate, rather everted at the brim, externally nodose and lumpy, internally even; stem smooth, rather compressed. Colour sponge-brown. Surface minutely conulated both externally and internally; conuli projecting through a soft, fleshy, fibro-reticulated, dermal structure, the interstices of which are occupied by the pore-areas, which are chiefly on the outside of the specimen. Vents circular, plentifully scattered over the inside, increasing in size towards the bottom of the cup, where there are two very large ones. Skeletal fibres sand-cored and transparent, the former main or primary, and the latter interuniting or secondary, producing together a reticulated structure which, on the outside of the vase, grows up into large, irregularly nodose or lumpy excrescences without any distinct form or arrangement, but on the inner side presents an even surface. Size of specimen:—Body 5 in. high by 3 in. in diameter; cup-like excavation about 2 in. deep and 4 in. in diameter across the brim.

Loc. Port Western.

Obs. This is so very like the form and description of Hyatt's

specimen, which came from the same neighbourhood, viz. "Phillip's Island," close to "Port Western," that I have given it his designation.

Besides these there are other massive specimens of *Hirciniæ* in Mr. Wilson's collection from Port Western, mostly small, which, but for the character of their keratose fibre, might be mistaken for colourless or grey *Aplysinæ*, since they present no particular shape, and, as I have before stated respecting the Aplysinidæ, much experience on the spot where an unlimited number of specimens can be obtained is necessary to reduce the whole here as well as elsewhere to their proper specific value, a task which the *great* number of species among the PSAMMONEMATA renders as important as at present it seems to be overwhelming.

Euspongia infundibuliformis, n. sp.

Vase-shaped or flabellate; infundibularly contracted towards the base where the stem has been truncated (probably by the dredge). Outer surface raised into thick, broken, subreticulate ridges, which radiate irregularly from the base to the circumference; inner surface even. Colour light brown. Surfaces (internal and external) uniformly covered with minutely conulated, sinuous ridges, projecting through an epithelial layer of nucleated circular cells, each about $2\frac{1}{2}$-6000ths in. in diameter, which, in its turn, rests on a soft, fleshy, dermal fibro-reticulation. Pores in the interstices of the reticulation, chiefly on the outside. Vents thickly distributed over the *inner* side, each about 1-18th in. in diameter, and for the most part respectively provided with a sarcodic sphinctral ring, subuniform in size and distribution, absent about the lower part of the cup; structure, although fine, very compact, chiefly composed of comparatively small keratose fibres of two kinds, viz. sand-cored and transparent, the former scanty and branching in more or less straight lines towards the surface, where they end in the conuli, the latter abundant and interuniting the former, but so delicate that they can only be seen with a microscope. Size of vasiform specimen (for there are two) 5 in. high both inside and out, wall $\frac{1}{4}$ in. thick, diameter across the brim 7 in.; stem, where it has been truncated, about 2 in. in diameter.

Loc. Port Western.

Obs. The exact height of this specimen cannot be given as the stem has been cut off. In its dried state it is firm and hard on the surface, on account of the presence of the dried sarcode over its compact structure, which, if thoroughly

washed out, as some specimens are among the waves, would have presented the usual woolly or soft structure of the finest "Turkey sponge." The flabellate specimen is (as I have before stated in many instances) only preparatory to the vase-shaped one, wherein the two sides of the former approximating become united, often, too, leaving a hole at the bottom.

There is another, but dried, cup-shaped specimen whose surface throughout is covered with a thick coating of sand mixed with the filaments of *Spongiophaga communis*; hence it is very hard, and the surfaces (inner and outer) respectively very smooth. It is 4 in. across the brim and 2 in. deep.

Order IV. RHAPHIDONEMATA.

Chalina oculata, var. *repens*, n. var.

Reptant, spreading over both sides of the flat fronds of a black olive *Fucus*, at least 8 in. long and 2 to 3 in. broad, covered with large circular vents respectively, terminating conical, monticular processes in juxtaposition. Colour light brown. Consistence resilient. Surface even, minutely fibro-reticulate. Pores in the interstices of the fibro-reticulation. Vents numerous, large, and circular, each terminating the summit of a flask-shaped or monticuliform individual which, in conjunction with others of the same kind, form the reptant crust of which the specimen is composed. Structure essentially keratose, that is without spicules; fibre reticulate and short-jointed, smaller on the surface than in the interior, supporting a thin sarcode charged with ova in an advanced state of segmentation. No spicules. Size of specimen about 8 in. long (that is, the size of the branches of the *Fucus* over which it has grown), about 1 in. thick.

Loc. Port Western.

Obs. This variety of *Chalina oculata* is evidently allied to the "knotty mass or crust-like" form of *Halichondria simulans*, Johnston (Brit. Spong. 1842, p. 109), whose relations I have noticed in connexion with specimens in the British Museum, being, from the nature of its keratose structure, a *Chalina* in one place and a *Reniera* in another ('Annals,' 1882, vol. ix. p. 277), to which I must refer the reader for further observations on the subject, as it bears upon the fact to which Schmidt alluded in 1870, viz. the connexion between *Chalina* and *Reneira* (Atlantisch. Spongienf. p. 37). It is illustrative of my family no. 3, viz. the "Reptata" (see Classification, 'Annals,' 1875, vol. xvi. p. 141), and is a repent variety of *Chalina oculata*, as described in the 'Annals' of 1885 (vol. xvi. p. 285). The absence of spicules is as

remarkable as it is unusual; but I have already alluded to the extreme smallness of these in the other specimens of Mr. Wilson's *Chalinæ* (*ib.* p. 284), and here they are *altogether* absent, while the fibre is only cored by a flocculent substance such as appears in the transparent fibre of the PSAMMONEMATA.

Acervochalina claviformis, n. sp.

Erect, cylindrical, clavate or pyriform, with the largest end uppermost. Consistence remarkably loose and tender. Colour grey-brown. Surface uniformly smooth, covered with a fine fibro-reticulation. Pores in the interstices of the reticulation. Vents numerous, very large and circular, with prominent or raised margin, scattered irregularly over the surface. Structure remarkably loose, composed of fibres cored with the spicules of the species, many of which project through the sides, supporting the sarcode abundantly traversed by large excretory canals which terminate respectively in the vents mentioned. Spicule of one form only, viz. acerate, smooth, curved, fusiform, sharp-pointed, about 40 by $1\frac{1}{2}$-6000th in., coring the fibre and more or less projecting through it. Size of specimen (of which there are two almost exactly alike, although coming from different localities), 5 in. high, $1\frac{1}{2}$ in. in diameter in the widest part of the head, and 5-8ths at the base, where it expands into a discoid root-like attachment.

Loc. Port Phillip Heads and Port Western.

Obs. This species, in the present instance, is chiefly characterized by its pyramidal erect form, large vents, and delicate structure, so that, if handled roughly, it would go to pieces.

Order V. ECHINONEMATA.

Plumohalichondria plumosa, var. *purpurea*, n. var.

Fig-shaped, the largest end upwards, growing on a fragment of the calcareous test of a Polyzoon. Consistence firm. Colour pinkish purple. Surface even, minutely reticulated. Pores in the interstices of the reticulation. Vents small, scattered over the summit. Structure compact; dermis pinkish, but internally light sponge-yellow, composed of sarcode supported on the spiculiferous fibre of the species, traversed by the canals of the excretory system. Spicules of two kinds, viz. skeletal and echinating:—1, skeletal spicules of two forms, viz. acuate, curved, scantily spined but chiefly towards the large end, about 45 by 2-6000ths in.; and acerate, smooth, curved or nearly straight (viz. the "tibiella"), more or less gradually pointed: 2, echinating spicule clavate, thickly

spined, spines large, viz. as long as the shaft is thick; total size about 20 by 3-6000ths in. Skeletal spicules of both forms mixed in the fibre, the "tibiella"* most numerous; No. 2, the echinating spicule, plentifully dispersed over the fibre.

Loc. Port Western.

Obs. This variety is chiefly characterized by the absence of a flesh-spicule, viz. the usual angulated equianchorate, together with the presence of a pinkish colour in the dermis, although in respect to the latter, when only superficial, I am always in doubt how far it may have been derived from the proximity of a similarly coloured sponge, ex. gr. *Suberites Wilsoni.*

Axinella chalinoides, var. *cribrosa* (dry).

Specimen a compressed cluster of polychotomous branches rising from a short thick stem with root-like expansion; branches finger-like, subcylindrical, subpointed, dividing more or less on the same plane, interuniting more or less midway between the stem and the free extremities. Consistence compressible, not hard. Colour fawn-colour. Surface cribrate generally. Pores not seen, probably in the holes of the cribration. Vents in great plurality, arranged linearly on each side of the subcylindrical branch, deeply sunk into the tissue and rendered stelliform by grooves radiating from them to the surface, probably in the fresh state consisting of subdermal branched venations of the excretory systems leading to the vents. Structure compact generally, that is not condensed axially; fibre strongly developed, short-jointed. Spicules acuate, of two sizes, viz. one comparatively stout and short, about 25 by 1-6000th in., and the other long and thin, about 50 by $\frac{1}{2}$-6000th in. in diameter—the former coring the fibre and projecting through it, especially towards the surface, which is thus rendered shortly hispid, and the latter both in the fibre with the former and loose in the surrounding sarcode. Size of specimen 9 in. high and 4 in. in its broad diameter.

Loc. Port Phillip Heads.

Obs. The rough cribrose surface together with the stelliform vents and acuate form of spicules of this species cause it to differ from, as much as the general form and linear arrangement of the vents cause it to resemble, the digitiform *Chalinæ.*

Axinella cladoflagellata, n. sp.

Long, round, attenuated, whip-like, branched, scantily divided, the whole rising from a short thick stem. Consistence firm. Colour grey. Surface even, granulated with

* "Tibiella," the name proposed for this spicule in the 'Annals' of 1881 (vol. vii. p. 369, pl. xviii. fig. 9, *b*).

little tufts of spicules that just project through the dermis where the latter is entire, but where the dermis is abraded, presenting a villous surface. Neither pores nor vents seen. (They are generally very small in these sponges, and on desiccation, from the compactness of the structure and the thickness in consistence of the sarcode, disappear altogether owing to the contraction of the latter.) Structure very compact and condensed in the axis, becoming less so towards the surface, also usual with these sponges. Spicules of one kind only, viz. long, acuate, entering thickly into the composition of the axis, and appearing at the circumference in the little "tufts" mentioned. Size of specimen 1 ft. long; stem thin, long, 5-8ths in. in diameter.

Loc. Port Western.

Obs. This is simply a *Dictyocylindrus* without echinating spicules, and therefore called an "*Axinella.*"

Axinella coccinea, n. sp.

Massive, lobodigitate, digitations united, contracted towards the base, stipitate. Consistence lax. Colour rich deep purple-red throughout. Surface even, smooth, fibro-reticulate, covered by thin dermis. Pores in the interstices of the reticulation. Vents conical, at the ends of the digitations respectively. Structure lax, fibrous, consisting of spiculiferous fibre stained by the red colouring-matter exuding from the granules of the sponge; supporting sarcode plentifully charged with dark red-purple granuliferous, pigmental cells, whose cell-wall is colourless and about 10-6000ths in. in diameter, accompanied by the granules also *separately*, in the form of minute, spherical, pigmental cellulæ about 2-6000ths in., which have become extravasated into the tissue generally, but of which I could see neither on the surface in the form of *epithelial* cells; structure traversed plentifully by the canals of the excretory canal-system. Spicule of one form only, viz. acuate, smooth, curved, rather abruptly pointed at one end, round at the other, about 55 by $1\frac{1}{2}$-6000th in.; coring the fibre, and here and there projecting through it subechinatingly. Size of specimen 6 in. high by 4×4 in. in its greatest horizontal diameters.

Loc. Port Western.

Obs. This differs from *Axinella atropurpurea*, viz. the similarly coloured specimen already described ('Annals,' 1885, vol. xvi. pp. 359, 360), both in general form and spiculation, as may be seen by comparing the descriptions respectively; but the colouring-matter and its persistence is the same, that is to say it is neither altered by preservation in spirit nor by desiccation. I am in doubt, from its loose structure, whether it ought not to be considered a *Chalina.*

Phakellia ventilabrum, var. *australiensis*, n. var.

Specimen flat, thin, wedge-shaped. Consistence firm. Colour grey. Surface even, consisting of a thin, white dermal crust of small spicules arranged cribrately, covering both sides of the frond and continuous over the margin, which is round. Pores in the minute holes of the cribriform crust. Vents not seen. Structure consisting of fine, dense, kerataceous, spiculiferous fibre. Spicules of one form only, viz. a simple acuate, of two sizes, coring the fibre and composing the dermal layer respectively, much larger in the former than in the latter. Size of specimen 7 in. high, 6 in. broad at the upper margin, and 2-8ths in. thick.

Loc. Port Western.

Obs. The sinuous spicule which is present in the British species, viz. *Phakellia ventilabrum*, is here absent.

Phakellia papyracea (dry).

Flabelliform, more or less slit in through the margin or lobed, very thin, papyraceous. Consistence tough, stem hard. Surface of the lobes or divisions concentrically lineated. Pores numerous, minute, general, undistinguishable in size from the vents. Fibre tough, keratose, short-jointed, and dense; cored and subechinated by the spicules of the species. Spicules of two forms, viz. :—1, comparatively stout, smooth, acuate, curved, varying in size under 50-6000ths in. long by 2-6000ths in. in its thickest part; 2, thin, sub-pinlike, 60-6000ths in. long by $\frac{2}{3}$-6000th in. thick. The former coring and projecting through the keratose fibre subechinatingly, the latter confined to the sarcode about no. 1. Size of largest specimen, for there are two, 9 in. high, including the stem (which is round, 2 in. long and $\frac{3}{8}$ in. in diameter), 10 in. broad, and about $\frac{1}{8}$ in. thick, thinning towards the margin.

Loc. Port Western.

Phakellia villosa, n. sp.

Undulating, texture-like, or in the form of a vase, with continuous undulating, infoliated, thin wall and margin; stem truncated (probably by the dredge). Consistence firm. Colour purplish. Surface even, villous, soft. Poriferous generally on the outer surface. Vents, or rather excretory canal-systems, in the form of little stelliform branched venations scattered subuniformly over the inner surface. Spicules of one form only, viz. acuate, smooth, short, thick, curved, 53 by 3-6000ths in., coring the fibre and projecting through it echinatingly. Size of vasiform specimen 4 in. high by 3 in. across the brim, wall 2-8ths in. thick.

Loc. Port Western.

[To be continued.]

XXXVIII.—*On the Molluscan Fauna of the Gulf of Suez in its Relation to that of other Seas.* By Alfred Hands Cooke, M.A., Curator in Zoology, Museum of Zoology and Comparative Anatomy, Cambridge.

In his original article on the Mollusca of the Gulf of Suez (Ann. & Mag. Nat. Hist. 1870, vol. vi. pp. 429–450) Mr. MacAndrew wrote as follows:—"The total number of species of Mollusca I obtained in the Gulf of Suez amounts to some 818, of which 619 have been identified or described, the remaining 199 being still undetermined."

The result of my investigations (Ann. & Mag. Nat. Hist. April 1885, pp. 322–339, July 1885, pp. 32–50, Oct. 1885, pp. 262–276, Feb. 1886, pp. 128–142, Aug. 1886, pp. 92–109) has been materially to reduce the above estimate. As has been already remarked in the course of previous communications, the collection was originally identified largely with the view of discovering as many species as possible. I will make bold to say that out of the "199 species undetermined" not 30 have proved on examination new or different from species in the collection already identified.

Issel's list of Red-Sea Mollusca ('Malacologia del Mar Rosso,' Pisa, 1869) contains, exclusive of 35 species of Nudibranchs, about 356 species of Gasteropoda and about 172 of Lamellibranchiata, or a total of about 528 species. The MacAndrew collection, as now revised, contains about 419 species of Gasteropoda and about 189 of Lamellibranchiata, or a total of about 608 species.

The geographical range of the Red-Sea Mollusca is exceedingly interesting. Broadly speaking, the area of distribution extends over a vast extent of sea-coast, of which Suez forms the extreme western and the Sandwich Islands the extreme eastern point, while the north and south range extends from Japan to Natal, and even to the Cape of Good Hope. The point on the Japanese coast where the line should be drawn which may be said to separate the tropical Mollusca from those of decidedly northern character appears to lie off the mouth of the river Amur, the marine fauna of the Sea of Ochotsk being markedly northern. And it is remarkable to notice how sharply the line of demarcation is drawn at the Cape and at the Sandwich Islands. In the former case the great Antarctic current, sweeping up from the Pole along the west coast of South Africa, stops like a wall the progress of east-coast species, accustomed as they are to much warmer

water. In the latter the great distance between the Sandwich Islands and the opposite coasts of America, and the cold polar current which pours down from the north in a course parallel to those coasts, form obstacles too great for the fry of tropical Mollusca to overpass; and, so far as I am aware, it cannot be shown that a single species has succeeded in crossing them in this direction. It is quite true that a few Suez species (not more, perhaps, than half a dozen in all) are found on the West-Mexican coast; but there is no evidence to show that they got there *viâ* the Sandwich Islands. On the contrary, their existence (speaking more particularly of *Triton pilearis* and *Lucina quadrisulcata*) in the West Indies tends to show that their appearance on the W.-Mexican coast dates from a time when the Isthmus of Panama was not yet closed. And it appears to me that, though the distance may be far greater, yet the presence of East-Indian species in the West Indies and on the West-Mexican coast is far more easily accounted for by a trans-Atlantic than by a trans-Pacific migration, especially when it is borne in mind that the Isthmuses of Panama and Suez have both been open, each of them perhaps more than once, within late geological times. For in the case of the Atlantic we have a series of warm currents trending generally from the west coast of Africa towards Brazil *; while in the case of the Pacific the cold polar current sweeping down from the north parallel to the American coast, and the enormous distance without any perceptible set of current to the east, present just as insurmountable a barrier as the Antarctic current in S. Africa.

Of the enormous area of distribution whose normal limits have been indicated above, there is a district which may probably be regarded as the nucleus. If it is possible to approximate in any degree to the original birthplace of a single species, whether vertebrate or invertebrate, the same must be true, though of course in a wider and less specific sense, for groups of species also. If it is granted that a particular species develops at a particular place (using the term in a wide sense), and not, whether contemporaneously or at different periods, at different places, it is evident that indications may be discovered which will tend to show where that place was, and the process may be extended to groups of species as well. It appears to me that the Philippine district may be regarded as the centre of distribution of those species which radiate westward as far as Suez, northward as far as

* Studer states (Abh. Ak. Berlin, 1882, p. 5) that out of 541 marine shells from the west coast of Africa 55 are common to the opposite coast of America.

Japan, and eastward as far as the Sandwich Islands. There are, as is well known, special reasons which tend to make the marine fauna of the Philippines better known to us than that of, *e. g.*, the Seychelles or the Maldives; and possibly it is only because we have more detailed information as to the species of Mollusca resident at the former locality that we at present prefer it to the latter, as indicating a radiating point of distribution.

The annexed table, compiled from the latest sources of information, is an attempt roughly to indicate the geographical distribution of the Mollusca of Suez. The two localities about which I feel dissatisfaction, being sure that the figures given do not indicate their real relation to the Suez shells, are Natal and E. Australia. For the former Krauss's 'Südafrikanischen Mollusken' (1848) was my only authority; while the latter, north of Moreton Bay, is a region practically unexplored, but whose tropical climate and comparative nearness to the Philippines assure it a much closer relation to them than the figures given would seem to imply.

The Gasteropoda alone have been worked out, as the information with regard to the Lamellibranchiata was often so scanty as to lead to practically no result.

Gasteropoda. Suez.	Common to Philippines.	Common to Japan.	Common to Natal.	Common to E. or S. Australia.	Common to Sandwich Is.
419	214 or 51 p. c.	55 or 13 p. c.	35 or 8 p. c.	24 or 6 p. c.	38 or 9 p. c.

The 55 Suez Gasteropoda common to Japan are:—

Pteroceras bryonia, *Gmel.*
Terebellum subulatum, *Lam.*
Urosalpinx contractus, *Reeve.*
Fasciolaria trapezium, *L.*
Cantharus rubiginosus, *Reeve.*
Nassa gemmulata, *Lam.*
Columbella flavida, *Lam.*
Acus subulata, *L.*
Ricinula ricinus, *L.*
Rapana bulbosa, *Sol.*
Coralliophila madreporarum, *Sow.*
Ranella hians, *Schum.*
Triton tritonis, *L.*
—— pilearis, *Lam.*
Cassis vibex, *L.*
Mitra pretiosa, *Reeve.*
—— obeliscus, *Reeve.*
Cypræa fimbriata, *Gmel.*

Cypræa arabica, *L.*
—— moneta, *L.*
—— caurica, *L.*
—— erosa, *L.*
—— lynx, *L.*
Conus miliaris, *Hwass.*
—— textile, *L.*
Turris violacea, *Hinds.*
Pyramidella gracilis, *A. Ad.*
Obeliscus balteatus, *A. Ad.*
Syrnola pulchella, *A. Ad.*
—— aclis, *A. Ad.*
—— aciculata, *A. Ad.*
—— pupina, *A. Ad.*
—— cinctella, *A. Ad.*
Turbonilla fusca, *A. Ad.*
—— modica, *A. Ad.*
Styloptygma lendix, *A. Ad.*
Cingulina circinata, *A. Ad.*
Styliferina goniocheila, *A. Ad.*
Vertagus Kochi, *Phil.*
Triphoris corrugata, *Hinds.*
Planaxis sulcatus, *Born.*
Cyclostrema cingulifera, *A. Ad.*
Morchia obvoluta, *A. Ad.*
Hyala pumila, *A. Ad.*
Onoba mirifica, *A. Ad.*
Fenella pupoides, *A. Ad.*
—— scabra, *A. Ad.*
—— reticulata, *A. Ad.*
—— rufocincta, *A. Ad.*
Alaba imbricata, *A. Ad.*
—— lucida, *A. Ad.*
Diala varia, *A. Ad.*
Scutus unguis, *L.*
Hydatina physis, *L.*
Tornatina fusiformis, *A. Ad.*

The 35 Suez Gasteropoda common to Natal are :—

Strombus gibberulus, *L.*
—— floridus, *Lam.*
Fasciolaria trapezium, *L.*
Melongena paradisaica, *Reeve.*
Cantharus rubiginosus, *Reeve.*
Nassa pulchella, *A. Ad.*
Columbella turturina, *Lam.*
Engina mendicaria, *Lam.*
Ricinula ricinus, *L.*
Sistrum anaxares, *d'Orb.*
—— fiscellum, *Chemn.*
—— tuberculatum, *Blainv.*
—— asperum, *Lam.*
—— heptagonale, *Reeve.*
Ranella affinis, *Brod.*
—— pusilla, *Brod.*
Triton pilearis, *Lam.*
Cypræa fimbriata, *Gmel.*
Cypræa arabica, *L.*
—— annulus, *L.*
—— erosa, *L.*
—— lynx, *L.*
Conus lividus, *Hwass.*
Cerithium morus, *Lam.*
Colina contracta, *Sow.*
Planaxis sulcatus, *Born.*
Nerita polita, *L.*
—— histrio, *L.*
Monodonta australis, *Lam.*
—— obscura, *Wood.*
Littorina scabra, *L.*
Scutus unguis, *L.*
Hydatina physis, *L.*
Philine aperta, *L.*
Siphonaria kurrachensis, *Reeve.*

The 24 Suez Gasteropoda common to E. or S. Australia (including Tasmania) are :—

Fasciolaria trapezium, *L.*
Sistrum tuberculatum, *Blainv.*
Coralliophila madreporarum, *Sow.*
Ranella affinis, *Brod.*
Epidromus bracteatus, *Hinds.*
Cypræa arabica, *L.*
—— annulus, *L.*
—— caurica, *L.*
—— erosa, *L.*
—— lynx, *L.*
Daphnella vincentina, *Crosse.*
Defrancia tenuilirata, *Angas.*
Turbonilla fusca, *A. Ad.*
Myonia amœna, *A. Ad.*
Smaragdia pulcherrima, *Angas.*
? Cingulina circinata, *A. Ad.*
? Bittium tenue, *Sow.*
Littorina scabra, *L.*
Scutus unguis, *L.*
Acanthopleurus piceus, *Gmel.*
Actæon coccinatus, *Reeve.*
Hydatina physis, *L.*
Tornatina fusiformis, *A. Ad.*
Philine aperta, *L.*

The 38 Suez Gasteropoda common to the Sandwich Islands are:—

Terebra babylonia, *Lam.*
—— columellaris, *Hinds.*
Triton rubecula, *Lam.*
Mitra filosa, *Born.*
—— annulata, *Reeve.*
—— cucumerina, *Lam.*
—— mucronata, *Swains.*
—— aureolata, *Swains.*
—— alauda, *Sow.*
—— litterata, *Linn.*
Cypræa carneola, *Lam.*
—— talpa, *L.*
—— isabella, *L.*
—— erosa, *L.*
—— lynx, *L.*
Trivia oryza, *L.*
—— tremeza, *Ducl.*
—— nucleus, *L.*
—— cicercula, *L.*
Conus lividus, *Hwass.*
—— ceylonensis, *Hwass.*
—— flavidus, *Lam.*
—— tessellatus, *Born.*
—— virgo, *L.*
—— miliaris, *Hwass.*
—— nussatella, *L.*
Turris monilifera, *Pease.*
Natica maroccana, *Chemn.*
Pyramidella corrugata, *Lam.*
Obeliscus sulcatus, *A. Ad.*
Cerithium rugosum, *Wood.*
Triphoris rubra, *Hinds.*
Gena nigra, *Quoy.*
Rissoina tridentata, *Mich.*
Littorina scabra, *L.*
Modulus tectum, *Gmel.*
Bulla ampulla, *L.*
Atys semistriata, *Pease.*

The following 2 Suez species appear to be common to Japan, Natal, E. or S. Australia, and the Sandwich Islands:—

Cypræa erosa, *L.*
Cypræa lynx, *L.*

Taking together the two northern and the two southern of these localities we arrive at a result which, as we should expect, indicates a closer connexion between S. Africa and S. Australia than between Japan and the Sandwich Islands; thus:—

The following 10 Suez species are common to Natal and S. Australia:—

Fasciolaria trapezium, *L.*
Littorina scabra, *L.*
Sistrum tuberculatum, *Blainv.*
Ranella affinis, *Brod.*
Cypræa arabica, *L.*
Cypræa annulus, *L.*
—— erosa, *L.*
—— lynx, *L.*
Hydatina physis, *L.*
Philine aperta, *L.*

The following 3 Suez species are common to Japan and the Sandwich Islands:—

Cypræa erosa, *L.*
—— lynx, *L.*
Conus miliaris, *Hwass.*

The following 4 Suez species reach New Zealand *:—

Ricinula ricinus, *L.*
Cypræa annulus, *L.*
Scutus unguis, *L.*
Philine aperta, *L.*

* Tryon, in his 'Manual of Conchology,' vol. iii., gives, on what authority I do not know, New Zealand as a locality for *Triton tritonis*. It does not occur in Hutton's admirable list of the shells of New Zealand.

Three Suez species appear to occur at St. Helena * :—

Triton tritonis, *L.*
Cypræa moneta, *L.*
Cypræa turdus, *L.*

Two Suez species, which do not occur in the Mediterranean, occur at the Canary Islands :—

Natica maroccana, *Chemn.*, var.
Natica variabilis, *Récl.*

Four Suez species reach the West Indies, viz. :—

Triton pilearis, *Lam.*
Natica maroccana, *Chemn.*
Acanthopleurus piceus, *Gmel.*

Leuconia denticulata, *Mont.*

Two Suez species occur on the west coast of Central America, viz. :—

Triton pilearis, *Lam.*
Natica maroccana, *Chemn.*, var.

Further examination, and careful preparation of local collections will no doubt add enormously to the length of the lists here given ; but I do not anticipate that their relative proportions will be very largely modified.

The question whether any species of shells are common to the Red Sea and the Mediterranean has often been debated, and is still *sub judice.* But it seems a not unreasonable assumption that the MacAndrew collection of Suez shells affords an opportunity for making a considerable step in the direction of a settlement, not only because of the unusually fine series of specimens which it offers in every stage of growth, but because the same gentleman made very large collections in the Mediterranean, equally rich in series illustrating young and adult forms. It should be mentioned that he was most scrupulously careful in labelling his captures with the exact locality, so that the idea cannot be for a moment entertained that the specimens from the two seas have become mixed up in the cabinets. Thus we have the unusual opportunity of being able readily to compare large series of species, identical or related, drawn from both seas, and to form our conclusions accordingly.

* Since I wrote the above Mr. E. A. Smith has informed me that he has examined the actual specimens from which this statement (Melliss's 'St. Helena') was made. It appears, and I can confirm the observation, that the specimens identified as *Cypr. turdus* are all *Cypr. spurca,* while the two specimens of *Cypr. moneta* look most suspiciously like ballast shells.

Philippi seems to have been the first to institute any comparison between the Molluscan fauna of the Red Sea and Mediterranean. On comparing his Sicilian and Italian collections with those made in the Red Sea and deposited at Berlin by MM. Hemprich and Ehrenberg, he came to the conclusion * that the following species were common to both seas:—

Patella cærulea, *L.*
—— lusitanica, *Gmel.*
—— tarentina, *Lam.*
—— fragilis, *Ph.*
Fissurella græca, *L.*
—— costaria, *Desh.*
—— rosea, *Lam.*
Bulla striata, *Brug.*
—— truncata, *Ad.*
Eulima polita, *L.*
Chemnitzia elegantissima, *Mont.*
Truncatella truncatula, *Mont.*
Paludina thermalis, *L.*
Rissoa glabrata, *v. M.*
Natica olla, *M. de S.*
—— millepunctata, *Lam.*
Nerita viridis, *L.*
Ianthina bicolor, *Mke.*
Haliotis tuberculata, *L.*
Tornatella tornatilis, *L.*
Trochus crenulatus, *Broc.*
—— striatus, *L.*
—— Adansoni, *Payr.*
Trochus varius, *Gmel.*
Cerithium vulgatum, *Brug.*
—— mammillatum, *Risso.*
—— lima, *Brug.*
—— perversum, *Brug.*
Fasciolaria lignaria, *L.*
Fusus corneus, *L.*
—— syracusanus, *L.*
—— rostratus, *Oliv.*
Murex trunculus, *L.*
Tritonium variegatum, *Lam.*
Ranella lanceolata, *Mke.*
Dolium galea, *L.*
Buccinum variabile, *Ph.*
—— mutabile, *L.*
—— gibbosulum, *L.*
Mitra lutescens, *Lam.*
Marginella clandestina, *Broc.*
—— miliacea, *L.*
—— minuta, *Pfr.*
Cypræa moneta, *L.*
—— erosa, *L.*

Solen vagina, *L.*
—— legumen, *L.*
Mactra stultorum, *L.*
—— inflata, *Bronn.*
Corbula revoluta, *Broc.*
Diplodonta rotundata, *Mont.*
Lucina lactea, *Poli.*
—— pecten, *Lam.*
Mesodesma donacilla, *Lam.*
Donax trunculus, *L.*
Venus verrucosa, *L.*
—— decussata, *L.*
Cytherea exoleta, *L.*
—— lincta, *Lam.*
Cardita calyculata, *Brug.*
Arca Noæ, *L.*
—— tetragona, *Poli.*
—— barbata, *L.*
—— diluvii, *Lam.*
Pectunculus violacescens, *Lam.*
Nucula margaritacea, *Lam.*
Chama gryphoides, *L.*
Modiola discrepans, *Lam.*
—— Petagnæ, *Scac.*
—— lithophaga, *L.*
Pinna squamosa, *L.*
—— nobilis, *L.*
Spondylus aculeatus, *Chemn.*
Ostrea cristata, *Born.*

It would be needless to demonstrate the utter incorrectness of this list, the proportions of which no succeeding investigations have in the slightest degree tended to confirm. It is very obvious that the collection of MM. Hemprich and Ehrenberg, which numbered 375 species in all, had in some

* 'Enumeratio Molluscorum Siciliæ,' pp. 248, 249 (Berlin, 1836).

way become impregnated with a very strong Mediterranean leaven.

The opposite pole of belief is occupied by M. Fischer. That distinguished writer, in an article * on the shells collected by M. Vaillant at Suez (in which, however, only 86 species in all are enumerated), concludes that "il n'existe aucune coquille commune à la mer Rouge et à la Méditerranée." In a later article † M. Fischer, reasoning on the analogy of closely allied species occurring on both sides of the Isthmus of Panama, suggests a common derivation for closely allied species in the Red Sea and Mediterranean, such derivation to date from the Miocene period, after which he supposes the isthmus to have been finally closed.

Unfortunately M. Fischer had not sufficient material to support his theory, which indeed he rested entirely on the occurrence of *Cardium edule* (fossil) at Suez and (recent) along the isthmus, and on the erroneous idea that *Nassa gibbosula*, Gmel., was common to both seas.

This theory, however, which is in its main point thoroughly scientific, and which only failed in M. Fischer's hands from want of material, was adopted and established by Sign. Issel. That author, in the preface to his 'Malacologia del Mar Rosso,' after referring to Fischer's assertion of the entire difference between the two faunas, makes some remarkable observations, which are worth translating:—

"Though it would be incorrect to assert that there does not exist one single species common to the Mediterranean and the Red Sea (species being understood in the sense commonly accepted by conchologists), yet it is none the less true that there do not exist in the two seas two identical shells. The fact is, Mediterranean species which have been brought from the Red Sea all differ more or less from their respective typical forms. *Nassa costulata* of the Red Sea is more elongated and smaller; *Solecurtus strigilatus*, while remaining constant in form, shows on its valves closer and more numerous striæ; *Gastrochæna dubia* is more deeply striated than Mediterranean specimens.

"It might be objected that these forms, being so decidedly different, ought therefore to constitute distinct species, and therefore the assertion formulated by M. Fischer would be perfectly correct.

"To this we would answer that the distinctive characters observed by us in some Red-Sea varieties are not sufficient to characterize separate and distinct species (species being under-

* 'Journal de Conchyliologie,' 1865, pp. 97–127, 241 248.

† *Ib.* 1870, pp. 161–179; 1871, pp. 209–926.

stood in the narrowest acceptation of the term), because they are not sufficiently constant and because the groups in which they occur are subject to considerable variations in form (*sono i più polimorfi*).

"We, and other followers of the English school, while looking upon species as in theory very useful and, indeed, necessary for the study of the science, regard them as being to a large extent conventional and arbitrary, and believe that species vary according to the physical conditions in which they find themselves placed. Thus we should regard it as an abnormality, an exception to every rule, if there occurred in the Red Sea a Mediterranean species which had not undergone some modification.

"Besides the varieties indicated above there exist in the Red Sea certain shells differing indeed from their Mediterranean congeners, but sufficiently akin to them to stand as their representatives, so to speak, on the further side of the isthmus.

"Instances of this parallelism are found in *Nassa gibbosula* and *circumcincta*, *Cerithium vulgatum* and *Rüppellii*, *Cerith. conicum* and *Caillaudi*, *Chiton siculus* and *affinis*, *Diplodonta rotundata* and *Savignyi*, *Cardium edule* and *isthmicum*.

"Ought we to comprehend under the heading of *geographical variety* shells from the Red Sea, so near to the Mediterranean?

"Under this denomination are usually distinguished forms derived from a recognized type, which, by removal from the central point of their creation, have become gradually modified, and differ from it the more the greater is the distance which separates them from the point of departure. This is not the case with the shells now under consideration, because at certain points of the isthmus scarcely 100 kilometres separate the two faunas, and because such a short distance is not enough to constitute the existence of a geographical variety.

"These considerations have suggested the idea of distinguishing by a comprehensive term Red-Sea varieties and species which correspond to Mediterranean species. We will therefore give the name of *equivalent varieties* to those Mediterranean species which occur on the further side of the isthmus only slightly modified; and the name of *equivalent species* to those representatives of Mediterranean species which occur in the Red Sea modified to a larger extent.

"It is our belief that from any type, existent in a given place, there can be derived equivalent species and equivalent varieties if the locality has undergone more or less considerable changes; that, again, there can be derived geographical

varieties and geographical species, if the same type shall have become diffused over distant regions, gradually assuming new characters.

"It may reasonably be supposed, in the present case, that the species which in tolerably remote times (*e. g.* the Pliocene period) passed from the Mediterranean to the Arabian Gulf have undergone very considerable alterations of form, and have originated certain *equivalent species*, while those whose passage from one sea to the other was effected at a later (the Postpliocene) period have formed our *equivalent varieties.*"

Issel then proceeds to give the following lists, which I have slightly rearranged for the sake of clearness:—

Mediterranean Species.	*Equivalent Varieties in the Red Sea.*
Gastrochæna dubia, *Penn.*	Gastrochæna dubia, *Penn.*, var.
Solecurtus strigilatus, *L.*	Solecurtus strigilatus, *L.*, var.
Arca lactea, *L.*	Arca lactea, *L.*, var. erythræa.
Nassa costulata, *Ren.*	Nassa costulata, *Ren.*, var. erythræa.

Mediterranean Species.	*Equivalent Species in the Red Sea.*
Tellina exigua, *Poli.*	Tellina arsinoensis, *Issel.*
—— serrata, *Ren.*	—— Belcheriana, *Sow.*
Tapes geographicus, *Gmel.*	Tapes Deshayesii, *Hanl.*
Artemis exoleta, *L.*	Artemis radiata, *Reeve.*
Cardium edule, *L.*	Cardium isthmicum, *Issel.*
—— minimum, *Phil.*	—— sueziense, *Issel.*
Cardita sulcata, *Brug.*	Cardita angisulcata, *Reeve.*
—— trapezium, *L.*	—— variegata, *Brug.*
Diplodonta rotundata, *Mont.*	Diplodonta Savignyi, *Vaill.*
Lucina reticulata, *Poli.*	Lucina erythræa, *Issel.*
Arca diluvii, *Lam.*	Arca auriculata, *Lam.*
Modiola adriatica, *Lam.*	Modiola, sp.
Lima squamosa, *Lam.*	Lima bullifera, *Desh.*
Marginella minuta, *Pfr.*	Marginella sueziensis, *Iss.*
—— clandestina, *Br.*	—— pygmæa, *Iss.*
—— miliaria, *L.*	—— Savignyi, *Iss.*
Purpura hæmastoma, *L.*	Purpura, sp.
Nassa gibbosula, *L.*	Nassa circumcincta, *Reeve.*
Cerithium vulgatum, *L.*	Cerithium Rüppelli, *Phil.*
—— conicum, *Blainv.*	—— Caillaudi, *Pot. & Mich.*
Philine aperta, *L.*	Philine Vaillanti, *Iss.*
Ringicula buccinea, *Ren.*	Ringicula acuta, *Phil.*
Eulima Philippii, *Weink.*	Eulima Gentilomiana, *Iss.*
Neritina viridis, *L.*	Neritina Feuilleti, *Aud.*
Fissurella græca, *L.*	Fissurella Rüppellii, *Sow.*
Chiton siculus, *Gray.*	Chiton affinis, *Iss.*

These interesting, and in many respects valuable, remarks of Issel appear to me to be open to a certain amount of criticism. And, first, as to his denial of the term "geographical variety" to Red-Sea "equivalents" of Mediterranean species. He

seems to think that a geographical variety can only exist "at a great distance from the central point of the creation" of the type. Why? What is "a great distance"? One hundred kilometres, we are told, is too short a distance to constitute the existence of a geographical variety. Would two hundred kilometres be enough? Would a thousand? One is tempted to ask, How many kilometres make a geographical variety? *Arca lactea* occurs in the Philippines in a form precisely identical with that found at Suez. Are Philippine specimens to be called a "geographical variety" because they live a long way off the Mediterranean, but Red-Sea specimens an "equivalent variety" because they live nearly within 100 kilometres of it?

Nor is it easy to see the force of the adjective in the term under consideration. If "geographical" is meant to denote that the intervention of distance between one geographical point and another constitutes or compels variation, it states what is not true; if, on the other hand, that the type exists at one place and the variety at another, it is merely an "epitheton otiosum" and may be dispensed with altogether.

Again, the argument about the "central point of creation" is surely rather confused. Issel says (1) that geographical varieties originate at a great distance from the central point of creation, and (2) that the Red-Sea "equivalents" cannot be geographical varieties because they exist within 100 kilometres of the Mediterranean. It looks as if he placed the "central point of creation" for his four Mediterranean species, which have "equivalent varieties" in the Red Sea, at Port Said! And if it is replied that the central point of creation of a Mediterranean species cannot be established, but may be assumed to be any point where the type occurs, the answer is that in that case "central point of creation" is only a synonym for "area of distribution."

The truth is, distance *quà* distance has nothing to do with the production or non-production of a variety. One can easily imagine a stretch of sea-bottom two thousand miles in length, and the same species of Mollusca existing, without the slightest variation, at one end and at the other. What prevents variation is not shortness of distance, but similarity of environment; and in the case of some of the Mollusca it is not even necessary that the area of similar physical conditions shall be unbroken. In the case of a species which, in a certain stage of its existence, is free-swimming, the typical form is possessed of means of locomotion far surpassing those of the more sedentary species.

This is no doubt the explanation, though it has not yet

been proved in every case, of the enormous range of distribution shown by some of the Mollusca, not as varieties, but as constant *typical* forms. It is not to be imagined, for instance, that the whole extent of coast-line, littoral or sublittoral, from Suez to Hawaii, offers a suitable home to *Cypræa erosa.* But if the larval form is free-swimming, and if, when it returns from the open sea to the shore, it perishes at unsuitable lines of coast, but lives and flourishes on those which offer conditions of existence similar to those in which its ancestors have lived, we can understand why the typical form is preserved unvaried over a distance of many thousand miles. The distribution in a *typical form* of several of the large *Tritons* will, I have no doubt, have to be explained in a similar way.

Again, Issel's theory of "equivalent species" and "equivalent varieties" seems open to serious objection. He has made a list, as we have seen, of twenty-six "equivalent species" and of only four "equivalent varieties." But what is to determine the difference between the one and the other? What is to prevent our classifying *Tapes Deshayesii* as an equivalent variety and *Arca erythræa* as an equivalent species? Issel tells us that equivalent varieties are Mediterranean species "only slightly modified," and equivalent species are Mediterranean species "modified to a larger extent;" but who is to draw the line, and how? For since certain genera are notoriously liable to variation while others are remarkably constant, the amount of variation from the type which in some genera suffices to constitute a species, will in another genus be regarded as unimportant. The question is something more than a mere matter of words, if we go on to assume, as Issel does, that the "equivalent species" entered the Red Sea during the Pliocene period, while the "equivalent varieties" did not effect their passage from the Mediterranean till a later, or Postpliocene age.

Issel's grounds for refusing to classify his four "equivalent varieties" (*Nassa costulata, Solecurtus strigilatus, Gastrochæna dubia,* and *Arca lactea*) as "equivalent species" are two in number:—(1) the distinctive characters are not sufficiently constant; (2) the groups in which they occur are subject to considerable variation in form. These two reasons are really only two different ways of stating the same fact, namely, that the genera concerned are remarkably liable to variation. I should dispute this statement at the outset with regard to half the genera in question. Whatever may be said of the capacities of variation in *Gastrochæna* and *Arca,* I should be inclined to select the Solenidæ and Nassidæ, parti-

cularly the former, as including genera which, as genera go, are fairly constant in form. And further, if the reason Issel gives for distinguishing "equivalent varieties" from "equivalent species" be a valid one, it ought to be true for the one set of genera but inoperative with regard to the other; in other words, his "equivalent varieties" ought to belong to genera which are markedly variable, while his "equivalent species" ought to belong to genera which are fairly constant. So far is this from being the case, that half of the genera which supply him with "equivalent varieties" supply "equivalent species" as well. Why is *Arca auriculata* the "equivalent species" of *Arca diluvii*, but *Arca erythræa* only the "equivalent variety" of *Arca lactea*? Why, again, is *Nassa circumcincta* the "equivalent species" of *N. gibbosula*, while *N. costulata* (Ren.,=*variabilis*, Forb.) of the Mediterranean has only an "equivalent variety" in the Red Sea? Again, what genera are more notoriously liable to variation than *Tapes*, *Modiola*, and *Purpura*? Yet all the Red-Sea "equivalents" of Mediterranean species of these genera are classed by Issel as species, not as varieties. The reply will be, that it is a question of greater or less modification of form. But who is to measure "greater or less"? And what has become of the "groups of genera which are subject to considerable variation of form"?

These terms, "a variable genus," a genus "liable to variation," seem to me misleading, because they attempt to cover too much ground, but at the same time do not grasp all the facts as they present themselves to us. What one notices is, that certain genera, from their mode of life and habitat, are, so to speak, compelled to vary. Such genera, including *Ostrea*, *Vulsella*, *Chama*, *Avicula*, *Littorina*, *Vermetus*, *Crepidula*, *Patella*, &c., I should term genera necessarily variable. Again, one notices that certain other genera, while not necessarily variable, possess individual species which exhibit capacities for variation, while the bulk of the species remain fairly constant to the type. Such genera are:—*Conus*, fairly constant as a whole, but exhibiting such extremely variable species as *textile* and *hyæna*; *Natica*, with the variable *maroccana* and *mamilla*; *Nassa*, with the variable *gaudiosa* and *variabilis*; *Cardium*, with the variable *edule*. Thus, while a variable genus implies variation in the subordinate species, a variable species by no means implies a variable genus. Why some species should vary while others remain constant to the type is as yet unknown, but the fact is unquestionable.

It appears to me, then, that Issel's refusal of the term

"geographical varieties" to Red-Sea species akin to Mediterranean and his distinction between "equivalent species" and "equivalent varieties" alike fail, and fail for the very reasons he gives for establishing them. That Mediterranean species migrated into the Red Sea both in Pliocene and Postpliocene times no one can deny; but I do not believe that an examination of the recent species alone, as now existent on both sides of the isthmus, will enable us even approximately to conclude at which of the two periods particular species migrated. Issel assumes that the amount of variation from a supposed Mediterranean type is a fair measure of the time at which the variation began; in other words, of the time when the separation took place. *Nassa circumcincta* varies much from *N. gibbosula*, *therefore* it came over in the Pliocene period; *N. costulata*, var. *erythræa*, varies little from *N. costulata*, *therefore* it did not come over till the Postpliocene. This I should deny entirely, because it assumes as a basis of comparison what does not rest upon a shadow of foundation, viz. that all species form varieties with equal rapidity, and that it takes a longer time for a species to form a marked variety than it does to form a slight one.

The following marine shells, now living in the Mediterranean, occur in Postpliocene beds at Suez:—

Gastrochæna, sp. (*prob.* dubia, *Penn.*).
Solecurtus strigilatus, *L.*
Petricola Hemprichii, *Issel* (=lithophaga, *Retz*).
Arca lactea, *L.*
—— Noæ, *L.*
Modiolaria cœnobita, *Vaill.* (=marmorata, *Forb.*).
Nassa mutabilis, *L.*
—— costulata, *Ren.*
Murex trunculus, *L.*
Calyptræa chinensis, *L.*
Patella cærulea, *L.*

Donax trunculus, L., and *Cardium isthmicum*, Issel (=*edule*, L., var.), occur in the raised beaches of the Bitter Lakes, but not at Suez.

Five of these species (if *Arca Noæ* is not a misidentification of *arabica*, Forsk., and *Patella cærulea* of *rota*, Chemn.) are no longer living in the Red Sea, viz. *Nassa mutabilis*, *Murex trunculus*, *Calyptræa chinensis*, *Patella cærulea*, and *Arca Noæ*. Why these species should have ceased to exist in the Red Sea while others have lived and flourished is a point of which no satisfactory explanation can be offered. It is certainly not a case where littoral species have succumbed to a great increase of temperature. On the other hand, it is noticeable that of the remaining six species, Issel allows that two, viz. *Petricola Hemprichii* and *Modiolaria cœnobita*, still live in the Red Sea in the typical form. (*Murex trunculus* and *Nassa mutabilis* have both been reported as living in the Red

Sea, but on insufficient grounds.) It seems therefore likely, on *à priori* grounds alone, that representatives of the remaining four species exist also in the Red Sea in the typical form, and not, as Issel holds, as varieties.

My own views, as will have been gathered from preceding papers, while entirely discarding the extravagancies of Philippi, recognize a much closer connexion between the Mediterranean and Red-Sea species than does Issel. The similarity or dissimilarity, the union or separation of species cannot be settled in an offhand manner by the brief examination of a few picked museum specimens, but must be the result of a patient comparison of large numbers of examples *in every stage of growth* and in different phases of modification. Forms at first sight distinct will often be united by the discovery of an intermediate form, combining or modifying the peculiarities of both; and the more the investigation of the sea-bottom is carried on, the more these intermediate forms will inevitably occur. In the old days, when the conchologist was the collector and nothing else, an intermediate form was to him a *bête noire*—a creature which ran foul of his monographs and threatened to diminish the number of his species, and accordingly had to suffer suppression or destruction. The science has taken a turn since then, or rather has begun to deserve the name, and an intermediate form is now welcomed as an explanation, not scouted as a puzzle.

After the most careful examination of large series, drawn from both seas, I have come to the conclusion that the following species are, at the present time, common to the Mediterranean and the Red Sea; that is to say, that between specimens taken from the two seas no point of permanent varietal difference, however small, can be named which is not disproved by the examination of a large number of specimens. I believe, too, that if such specimens were mixed up together, a thoroughly good conchologist would be unable to separate them:—

Cerithium (Pirenella) mammillatum, *Risso* (=Caillaudi, *Pot. & Mich.*).
Emarginula elongata, *Costa*.
Chiton (Lophyrus) siculus, *Gray* (=affinis, *Issel*).
—— (Acanthochites) discrepans, *Brown*.
Volvula acuminata, *Brug.*
Philine aperta, *L.* (=Vaillanti, *Issel*).
(Leuconia denticulata, *Mont.*)
Pecten varius, *L.*
Lima inflata, *Chemn.*
Spondylus gæderopus (=species known as *aculeatus*, Chemn.).
Modiolaria marmorata, *Forb.* (=cœnobita, *Vaill.*).
Arca lactea, *L.*
Venerupis irus, *L.* (=macrophylla, *Desh.*, + derelicta, *Desh.* &c.).
Petricola lithophaga, *Retz.* (=Hemprichii, *Issel*).
Tellina balaustina, *Poli* (=Isseli, *H. Ad.*).
Gastrochæna dubia, *Penn.* (=Rüppellii, *Desh.*).
?Pholas dactylus, *L.* (=erythræa, *Gray*).

Besides the above seventeen species I should add the following two (which MacAndrew did not find at Suez) on the strength of Issel regarding them as varieties:—

Nassa costulata, *Ren.* Solecurtus strigilatus, *L.*

Thus, while holding to the undoubted fact that variation must be due to modification of physical conditions, I should maintain with Semper* that the converse is not necessarily the case, and that modification of physical conditions does not, in some cases, produce a measurable amount of variation. Why this should be the case must remain unexplained. It is possible that different conditions of temperature, different chemical constituents of water, &c., act less on certain species than on others, and that while a particular genus or a particular species would be profoundly modified by such differences as exist between the waters of the Red Sea and the Mediterranean, other genera and other species would remain practically unaffected. The facts seem to point in this direction, for how otherwise can we account for the extraordinary parallelism of species exhibited in Issel's list of equivalent species, and the simultaneous similarity of the species enumerated in the list given above. It has been shown that earlier or later dates of migration cannot be relied upon to explain these facts; the only true explanation must be that altered physical conditions act very unequally upon different genera, and even upon different species of the same genus.

It may at the same time be remarked that, for purposes of comparison between the water of the two seas, it will not be a fair test to take the mean amount of saltness, temperature, &c. of the Mediterranean generally and compare it with that of the Red Sea. The mean surface-temperature of the Mediterranean is, of course, considerably below that of the Red Sea, probably as much as 10° F., and, on *à priori* grounds, it would seem unlikely that Mollusca could endure a change of 10° F. in the temperature of the water in which they live without undergoing considerable modification. But the comparison must be made between the water from which the species actually migrated and that where they now are, viz. the water at Port Said and Suez, and then, as far as temperature at least is concerned, there is no very marked difference. The mean annual surface-temperature † of the sea at Port Said is 70°–71° F.,

* "Hence every change, as for example in the composition of the water of a lake or river, will not affect the fauna inhabiting it equally and as a whole, but will act on individuals; some will bear the change without being in any way affected by it, others will die, while others again will survive; but their habits of life will be changed, and at the same time their structure will be modified."—*Semper*, '*Animal Life*,' p. 177.

† Taken from the publications of the Meteorological Office.

the minimum being 62°, the maximum 80°; the same at Suez is 74°–75° F., minimum 68°, maximum 80°. This, it must be remembered, is the surface-temperature, and any difference therein exhibited would have a tendency to diminish when the water at several fathoms' depth was examined. It does not appear that the amount of salt contained in the sea-water at these places has ever been definitely compared by experiment; but, judging from what one can learn of the water at Suez *, and of the average saltness of the Mediterranean †, there does not appear to be any large difference between them.

That separation from the parent stock will in the end prevail, and that these Red-Sea shells will gradually become more and more unlike their Mediterranean ancestors, is not denied. Differences, however slight, may in the end establish themselves, though it be quite possible that the Suez Canal may do something towards the equalization of the character of the water of the two seas as well as in introducing fresh batches of the parent stock. It seems no unreasonable assumption that species which were the first to migrate in Postpliocene times will be the first to migrate now; at any rate, they are at least as likely to migrate as any others. At the same time I fully anticipate that, as the Red Sea becomes better explored, forms will be discovered which will connect species hitherto regarded as distinct, and thus the list that I have here presented will become gradually increased.

It only remains to mention in this last connexion a very interesting and remarkable paper by Dr. Conrad Heller ‡, which shows that the opening of the Suez Canal has, apparently, already induced several species of Mollusca to start on their travels, not only from the Mediterranean to the Red Sea, but in the reverse direction as well. Indeed, while at least two undoubted Red-Sea species (*Mactra olorina*, Phil., and *Mytilus variabilis*, Krauss) had, in 1882, established themselves at Port Said, only one Mediterranean species (*Cardium edule*, L.) had reached even the large Bitter Lakes, and it might possibly have been living there before, as *C. isthmicum*,

* The sea-water at Suez contains a very small fraction over 4 per cent. of saline matter. Maury, 'Phys. Geogr. of the Sea,' p. 190; Trans. Bomb. Geogr. Soc. vol. ix. 1849–50.

† "Recent experiments have shown that the water of the Mediterranean contains full 4 per cent. of salt. M. Bouillon la Grange investigated the subject with great perseverance, and his conclusion is, assuming the proportion of saline matter in the water of the Atlantic Ocean to be 38, that of the English Channel will be 36, and that of the Mediterranean 41."—*Smyth, 'Mediterranean,'* p. 127.

‡ "Die Fauna im Suez-Canal und die Diffusion der mediterraneen und erythräischen Thierwelt." Dated Zurich, Sept. 1882.

Issel. Two other species (*Pholas dactylus*, L., and *Solen vagina*, L.) had reached Ismailia. One could wish it were not so proverbially difficult to prove a negative; for, if *Mactra olorina* and *Mytilus variabilis* did not exist at Port Said, or in any part of the Mediterranean, prior to the opening of the Suez Canal (and in the total absence of evidence the other way, one may fairly assume this to have been the case), their passage from one sea to the other in the short space of thirteen years is an event remarkable in the history of distribution. It will be interesting, too, to notice whether the species in question have undergone, or are undergoing variations as a result of their change of locality.

XXXIX.—*Note on the Structure of* Crotalocrinus. By P. Herbert Carpenter, D.Sc., F.R.S., F.L.S., Assistant Master at Eton College.

The third part of Messrs. Wachsmuth and Springer's "Revision of the Palæocrinoidea," the second section of which has recently appeared*, contains the following statement respecting the suborder "Articulata," which, as defined by the authors, includes the family Ichthyocrinidæ, together with the three genera *Crotalocrinus*, *Enallocrinus*, and *Cleiocrinus*:—

"We maintain, however, that the outer test of the ventral side in this group was a continuous integument, composed of calcareous plates, united by ligament and not by a close suture, and that by reason of this structure and the articulation among the plates of the dorsal side it must have been pliant or flexible. . . . . . That there was an inner integument roofed in and covered by the flexible vault we have mentioned, and that it contained the summit-plates and 'covering pieces,' we know to be true in the Crotalocrinidæ, and we think it altogether probable that the general plan of the ventral structure for the Articulata generally is expressed in that of *Crotalocrinus*."

This last paragraph contains a somewhat positive and emphatic statement. The authors "know it to be true" that *Crotalocrinus* had a flexible vault above the summit-plates, which, be it remembered, themselves covered in the disk on which the peristome and ambulacra were situated. It has generally been considered hitherto that the summit-plates of

* Proc. Acad. Nat. Sci. Philad., March 30, 1886, p. 64. The paging of the separate copy is 140, and in future references the pagination of the entire work will be quoted, not that of the Philadelphia "Proceedings."

a Palæocrinoid, like the calyx-plates of the dorsal side, with which they were universally regarded as homologous, were placed on the extreme outside of the body, nothing but a thin film of perisome, covered by a pavement epithelium, intervening between the plates and the surrounding water. But we are now told as a positive fact, on the authority of Messrs. Wachsmuth and Springer, than which there is none higher, that *Crotalocrinus* and the Ichthyocrinidæ (a family which in many respects approaches the Neocrinoids more closely than any other Palæozoic forms) possessed the anomalous character of two vaults above the visceral mass—an inner one containing the actinal summit-plates and the covering plates, like the vault of *Platycrinus*, and an outer one of a more flexible character and composed of smaller plates belonging to the abactinal system.

Let us examine into the evidence which has led Wachsmuth and Springer to make this assertion. Neither *Crotalocrinus* nor *Enallocrinus* occurs in America; but both genera are found in the Silurian of the island of Gotland, and *Crotalocrinus* also occurs in the Dudley Limestone of this country. The National Museums of London and Stockholm contain remarkably fine specimens of these types, but unfortunately they have not been examined by Wachsmuth and Springer, whose knowledge of *Crotalocrinus* and *Enallocrinus* is principally, if not entirely, confined to the figures published by Müller, Angelin, and other authors; and I have a very strong conviction that the remarkable statement to which they have committed themselves so positively is due to a misinterpretation of these figures. By the kindness of Prof. G. Lindström I was able to examine the originals of many of Angelin's figures during a recent visit to Stockholm; and the examples of *Crotalocrinus* from Dudley, which are in the National Collection at South Kensington, have also come under my observation. These opportunities have convinced me that the "pliant vault" above the summit-plates, which is described by Wachsmuth and Springer in *Crotalocrinus*, had no existence in reality. They say on pp. 18 and 19 of part iii.:—

"In the Crotalocrinidæ, which include *Crotalocrinus* and *Enallocrinus*, the whole ventral surface, in what appear to be the best-preserved specimens, is composed of strong convex plates, without definite arrangement. In these specimens there is no central piece, nor proximals, nor traces of ambulacra (Icon. Crin. Suec., pl. 7, fig. 3 *a*; pl. 8, figs. 6, 7, and pl. 25, fig. 2); there are, however, other figures of Angelin, apparently of a closely allied species (Ibid. pl. 17, fig. 3 *a*), in which the plates paving the ventral surface are much more delicate, and consist of a central plate, large proximals,

and several rows of covering pieces, without the intervention of either anambulacral or interradial pieces. It would be difficult with the utmost stretch of our imagination to recognize in the former figures either proximals or central piece, which, as admitted by Carpenter, are present in all these Crinoids, and we think there can be little doubt that the two sets of figures represent different parts of the animal, the one the disk, the other the vault, and that the one covered the other. A similar opinion was evidently entertained by Zittel (Handb. d. Palæont., i. p. 357), who stated that *Crotalocrinus* possessed five 'grosse Oralplatten, bald unter der Decke, bald äusserlich sichtbar.' According to our interpretation the calyx of the Crotalocrinidæ extends ventrally to the oral pole, and the ambulacra, central piece, and proximals are subtegminal, covered by interradial plates, which extend out to the lower rows of covering plates and side pieces (Icon. Crin. Suec., pl. 7, fig. 6, and pl. 25, fig. 15). A similar condition probably prevailed in the Ichthyocrinidæ, with which the Crotalocrinidæ have close affinities."

Of Angelin's four figures first referred to by Wachsmuth and Springer in the above paragraph, the first and last (tab. vii. fig. 3 *a*, and tab. xxv. fig. 2) represent *Enallocrinus scriptus*, and the other two (tab. viii. figs. 6 & 7) *Crotalocrinus pulcher*. Fig. 3 *a* on tab. xvii. represents the vault of *Crotalocrinus rugosus*, and the central plate with the four anterior proximals is very distinct, as admitted by Wachsmuth and Springer. But when they state that "there is no central piece, nor proximals, nor traces of ambulacra" in the figures of *Crotalocrinus pulcher* and *Enallocrinus scriptus* they appear to me to be seriously in error.

No one knows better than the American authors that while the summit-plates are clear and well defined in some species and genera, there are other closely allied forms in which these plates are almost or entirely undistinguishable among the large number of plates to be found in the vault. I will now only mention one instance in illustration of this statement, viz. *Cyathocrinus iowensis* and *C. multibrachiatus*, both of which are figured by Wachsmuth and Springer *, the former with and the latter without very distinct summit-plates; and I might name any number of similar cases in the arrangement of the plates of the Echinoderm apical system, especially among the Ophiurids.

But the argument used by Wachsmuth and Springer is of this kind:—1. The vault of *Crotalocrinus pulcher* and of *Enallocrinus scriptus* is composed of irregularly disposed plates, none of which are specially distinguishable as the summit-plates. 2. The vault of *Crotalocrinus rugosus*, how-

* 'Revision,' part iii. p. 65, pl. iv. fig. 6, and pl. v. fig. 7.

ever, contains distinct summit-plates belonging to the actinal system. 3. Therefore it is an "inner integument," and was in reality covered by a "flexible vault" composed of irregularly disposed plates belonging to the interradial portion of the calyx or abactinal system, such as form the external covering or vault of *Crotalocrinus pulcher* and *Enallocrinus scriptus*.

The logic of this argument does not appear to me to be so sound that Messrs. Wachsmuth and Springer are entitled to say of their conclusion that they "know it to be true." It will be quite time enough to say this when they have discovered *either* the "inner integument" in *Crotalocrinus pulcher* or in *Enallocrinus scriptus*, *or* the "flexible vault" above this integument in *Crotalocrinus rugosus*; but from my own observation of two specimens of this latter type, both of them better preserved than that figured by Angelin, I feel myself entitled to say without fear of contradiction that the central plate and proximals were never covered up by such a "flexible vault" as that of which the existence is "known to be true" by Messrs. Wachsmuth and Springer.

For the sake of brevity I pass over their references to the absence of ambulacra in the summit of *Crotalocrinus pulcher* and *Enallocrinus scriptus*, as figured by Angelin, and to the opinions of Zittel respecting the oral plates of *Crotalocrinus*—both of them points which are open to a considerable amount of discussion—and I will pass on to the other evidence which the American authors adduce in favour of their theory that the central summit-plate and proximals of *Crotalocrinus*, together with "the entire ventral surface" *, were covered by calyx-interradials extending upwards from the abactinal side, where, by the way, "only occasionally the first interradial is visible dorsally" †.

At the conclusion of the long paragraph quoted above, tab. vii. fig. 6 and tab. xxv. fig. 15 of Angelin's work are referred to in illustration of this theory; but fig. 6 on tab. vii. simply represents a side view of the calyx of *Crotalocrinus pulcher*, and I strongly suspect that the authors meant to quote fig. 6 on tab. viii., the summit view of this species to which I have just referred. They continue on p. 64 of part iii. :—

"The vault of the Crotalocrinidæ extends quite a distance into the free rays, as shown by Müller's and Angelin's figures (Icongr., pl. 6, figs. 6 and 7, also pl. 25, figs. 15 and 25, and Akademie der Wissenschaften, 1853, pl. 13, fig. 10). That those plates are not ambulacral pieces is proved by the fact that they cover the Saumplatten, and have a different style of ornamentation. Those

* 'Revision,' part iii. pp. 57 and 143. † *Ibid.* p. 149.

figures further prove that the ventral covering was pliable, or the arms could not have assumed that horizontal position and be folded in other specimens."

It is unfortunate that of the five figures referred to in the first sentence of the above passage only one is quoted correctly, viz. tab. xxv. fig. 15. The last figure on this plate is 20, and I am therefore at a loss to know which one is meant by pl. 25, fig. 25. Figs. 6 and 7 on tab. vi. represent *Eucrinus interradialis* and *E. ornatus*, and I strongly suspect that, as in the previous case, tab. viii. is the one to which the authors meant to refer; while Taf. viii. fig. 10 would have been a more correct citation of the figure of *Crotalocrinus pulcher* in Müller's memoir, "Ueber den Bau der Echinodermen," which is only illustrated by nine and not by thirteen plates.

It is to this latter figure and to fig. 15 on tab. xxv. of Angelin's work that I now wish to direct attention; for they are the two on which Wachsmuth and Springer especially rely as proving that the calyx-interradials of *Crotalocrinus*, which are so slightly developed on the dorsal side, not only cover the oral pole, but also extend out on to the free rays and roof in the ambulacral covering plates on their ventral side*.

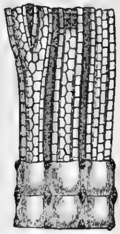
Most unfortunately, however, for the theory of the American authors, the figures in question represent *dorsal* and not *ventral* views of the "free rays," and their supposed "pliable ventral covering" formed of interradial plates consists of nothing but the arm-joints themselves. These are seen in their dorsal aspect at one end of Angelin's figure (which I have copied), but are removed elsewhere. This fact is fully explained by the three authors whom Wachsmuth and Springer quote, viz. Müller, Angelin, and Zittel; and it can only have been due to some extraordinary oversight on the part of the American writers that they allowed it to escape their notice. The result is an attempt to support their theory respecting the interradials of the Palæocrinoids by describing the *antiambulacral* arm-joints, which are nothing if not *radial*, as *superambulacral interradials*! But this theory breaks down altogether, so far as *Crotalocrinus* is concerned, when tested by facts.

Thus, for example, Müller says of his Taf. viii. fig. 10, "Strahlen der Hand, an welchen die Körper der Glieder zum Theil abgebrochen sind, so dass die kleinen Täfelchen an der Bauchseite der Glieder sichtbar sind."

In like manner Angelin, whose figure I have copied (see p.402), explained it as follows:—"Squamulæ tessellatæ ambu-

* Compare also the description of the "interradials" in the generic diagnosis of *Crotalocrinus* on p. 149 of the 'Revision,' part iii.

lacrorum subtus visæ, assulis connatis inferioribus brachii maximam partem demtis" *. Zittel, who gives a copy of



Portion of a free ray of *Crotalocrinus pulcher*, seen from the dorsal side. The arm-joints (interradials, W. & S.) are preserved at the proximal end of the specimen; but they have partially fallen away at the distal end, so as to expose the inferior or dorsal surfaces of the ambulacral covering plates. (After Angelin.)

this very same figure †, is still more explicit in his explanation of it:—"Die Armstücke von der Rückenseite, um die Verbindung derselben zu zeigen; gegen oben sind die Dorsalstücke weggebrochen und nur die Saumplatten und die Decktäfelchen der Ambulacralrinne von unten zu sehen."

So far then as the free rays of *Crotalocrinus* are concerned I do not think that Wachsmuth and Springer will again venture to assert that the covering plates were roofed over by a "pliable ventral covering" formed of calyx-interradials; and much of the following argument from pages 64 and 65 of part iii. is therefore altogether worthless:—

"This is of some importance as demonstrating that a pliable vault may enclose another flexible integument and contain the food-grooves underneath, which was seriously questioned by Carpenter (Chall. Rep., p. 182). He evidently overlooked *Crotalocrinus*, for we doubt if he could have taken the small covering plates (Icongr., pl. 17, fig. 3 *a*) for the representatives of the large rigid plates ‡ of figs. 6 and 7 on pl. 6, or the irregular pieces around the oral pole to be summit-plates."

It seems to me that the charge which Wachsmuth and Springer bring against me of having "evidently overlooked *Crotalocrinus*" has treated them like the proverbial chicken and come home to roost. I will again express my belief that

* In figure 16 of tab. xxv., which Angelin described as "Brachia connata subtus visa," the arm-joints (*interradials*, W. & S.), which are mostly removed in fig. 15, are seen in their natural position.

† 'Handbuch der Palæontologie,' i. Band, p. 357, fig. 244 *d*.

‡ It would be well if the authors would explain how these "rigid" plates can have formed part of a "pliant vault" which consisted of "a continuous integument of plates connected by ligament in place of suture" (p. 65).

the small covering plates of *Crotalocrinus rugosus* are the representatives in a smaller Crinoid of the "large rigid plates" shown in figs. 6 and 7, not on pl. 6, as Wachsmuth and Springer again quote it, but on tab. viii. of Angelin's 'Iconographia;' while I shall also continue to believe, until the contrary is demonstrated, that the central plate and proximals are among the irregular pieces occupying the oral pole in the originals of these two figures, and not beneath them, although Wachsmuth and Springer "know" this latter fact "to be true."

The question of the presence or (as I believe) the absence of a flexible vault composed of calyx-interradials above the summit-plates and covering pieces of *Crotalocrinus* is one of extreme importance in the morphology of the Palæocrinoidea, for Wachsmuth and Springer's *knowledge* of its existence is employed in many cases as an argument in favour of their views respecting the great development of the *abactinal* interradial plates of Palæocrinoids above the *actinal* side, and also for the purposes of classification.

We are told, for example, respecting *Crotalocrinus* and *Enallocrinus* *:—"The summit-plates in both genera are subtegminal, being covered completely by interradials, and the same was probably the case in the allied Ichthyocrinidæ, at least in their earlier forms. *Reteocrinus* and *Xenocrinus* were evidently in a similar condition, but it is not known whether they had summit-plates beneath the interradials or not." As I have before remarked †, the word "evidently" is here used by the authors as a short way of expressing "in our opinion." A little lower down the same page the supposed condition of *Reteocrinus* is also employed to enforce their argument:—

"It has been proved from palæontological evidence that in the earlier genera the interradials are more extravagantly developed than in later ones. In *Crotalocrinus* and *Reteocrinus* the interradials cover the entire ventral surface; in *Glyptocrinus* and *Glyptaster* they recede gradually toward the periphery, and the central space is filled by large proximals, and often by radial dome-plates. Considering these facts, is it safe to assert that in *Allagecrinus* and *Haplocrinus*, which are regarded as larval forms, interradials are entirely absent, and that all ventral plates are actinal? Is it not more reasonable to imagine that in these low forms the ventral side was covered by the one plate in a similar manner as in *Crotalocrinus*, *Reteocrinus*, and *Glyptocrinus* by the whole collection of plates? In the Neocrinoidea, from the larva to the adult, all ventral plates are actinal, but in all Palæozoic Crinoids, and we may say in all Palæozoic Pelmatozoa, the whole, or at least the

* 'Revision,' part iii. p. 57.

† Ann. & Mag. Nat. Hist. March 1886, ser. 5, vol. xvii. p. 288.

greater part, of the ventral side is abactinal, and this we consider one of the best distinctions between the two groups."

But since this somewhat extensive generalization is very largely based upon the authors' totally erroneous ideas respecting the structure of the summit in the Crotalocrinidæ, I do not believe that it expresses such an extremely important distinction between the Neocrinoids and the Palæocrinoids as they endeavour to make out. This passage, however, is employed as an argument to prove that the plates hitherto considered as orals in the permanent larval forms *Haplocrinus* and *Allagecrinus* * are not orals at all, but calyx-interradials which cover in the disk and, in the case of *Allagecrinus*, the summit-plates as well. But as the "extravagant development" of the interradials in the Silurian *Crotalocrinus* turns out to be an utterly erroneous theory, which has no other foundation than a complete misconception of Angelin's figures on the part of Messrs. Wachsmuth and Springer, they will have to seriously reconsider a great deal of the reasoning which they have based upon it respecting the homologies of the summit-plates in Neocrinoidea and Palæocrinoidea respectively. I have no intention, however, of taking up this discussion again at present, and I will pass on to a few words on the classification of Palæocrinoids.

Wachsmuth and Springer established the suborder Articulata "to include the group formerly defined by us under the family name Ichthyocrinidæ, with the addition of *Crotalocrinus* and *Enallocrinus*, which possess in a remarkable degree some of the most characteristic features of the group;" † and they say further on—"we think it altogether probable that the general plan of the ventral structure for the Articulata generally is expressed in that of *Crotalocrinus*."

I have endeavoured to show, however, that their theory as to the ventral structure of *Crotalocrinus* is altogether incorrect, owing to a faulty interpretation of Angelin's figures and to their want of personal acquaintance with the actual fossils. But the supposed existence of a flexible vault in *Crotalocrinus* is one of the reasons adduced by Wachsmuth and Springer for placing this genus among the Articulata, viz. those Crinoids "in which the plates of the test are united by loose ligaments or muscles, and in which they are somewhat movable" ‡. So far as my knowledge goes, however, it has yet to be proved that there was any such articulated arrange-

* "On *Allagecrinus*, the Representative of a new Family from the Carboniferous-Limestone Series of Scotland," Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. vii. pp. 285, 286.

† 'Revision,' part iii. p. 140.

‡ *Ibid.* p. 6.

ment of the calyx-plates in the Crotalocrinidæ as occurs in *Forbesiocrinus* and in the Ichthyocrinidæ generally.

But if this proof be not forthcoming, *Crotalocrinus* and *Enallocrinus* must be removed from the Articulata and assigned to some other group of the Palæocrinoidea; and as this is a subject which I do not feel myself qualified to discuss, I prefer to leave it to the much more experienced judgment of Messrs. Wachsmuth and Springer.

There is another point in the structure of *Crotalocrinus* on which my recent observations at Stockholm enable me to throw some light, or, rather, to correct an erroneous impression which has got abroad.

On page 12 of the 'Revision,' part i.(1879), Wachsmuth and Springer wrote as follows:—

"The so-called 'consolidating-apparatus' of *Cupressocrinus* is in our opinion a true set of hydrospires, arranged in pairs exactly as in Blastoids, but spreading out horizontally instead of vertically. Angelin (Icongr. Crin., pl. viii. fig. 7, *a*, *b*) figures a *Crotalocrinus* in which the consolidating apparatus—or hydrospires, as we believe—is most excellently preserved. Even the inner tubes can be traced, and, if there still existed a doubt whether the closely related *Cupressocrinus* had its ventral side firmly closed, Angelin's figure, pl. viii. fig. 6, ought to remove it. There seems to be in *Crotalocrinus* not only a solid integument covering the entire ventral disc and inclosing the hydrospires, but we judge from fig. 7 of the preceding plate, that the oral centre or median space between the hydrospires had even a double covering."

The authors' theory that the consolidating apparatus of *Cupressocrinus* represents the hydrospires of the Blastoids has since been abandoned, and the explanation of its structure which they have adopted will be found on p. 178 of the 'Revision,' part iii. section 2. I have the strongest conviction that they will also have to abandon their theory as to the internal hydrospires of *Crotalocrinus*. They are singularly unfortunate in giving so many wrong references to Angelin's figures of this genus; for the one on which they rely as proving the existence of hydrospires is on tab. vii., and not on tab. viii., as they state. It is described in the explanation as follows:—"Calyx superne visus, cum parte brachii, magnitudine paullum aucta. Apparatus quem consolidantem vocant, intus visus." It is to some extent upon this figure that Wachsmuth and Springer's theory as to the existence of a pliable vault in *Crotalocrinus* was based, foreshadowed, it will be noted, as early as the year 1879.

Unfortunately, however, the figure represents not the *ventral*, but the *dorsal* aspect of the broken calyx, and

"superne" should read "inferne" in the explanation of it. This is at once evident from the fact that there are no ambulacral grooves visible upon the skeleton of the arms, such as are shown in the representations of the same species (*Crotalocrinus pulcher*) on tab. viii. figs. 6 and 7. The calyx is broken across near the level of the tops of the basals, so that the internal faces of the radials and the following plates are exposed to view, with the remarkable striations upon them which were regarded by Angelin as corresponding to the consolidating apparatus of *Cupressocrinus*. It is possible that, like this structure, they may represent an uneven surface for the attachment of muscles and ligaments; but whatever else they may be, the striæ are certainly not hydrospire-slits, as supposed by Wachsmuth and Springer in 1879. They appear to have still held this view even as late as last year, when they published the first section of the third part of the 'Revision,' for we find a reference to the presence of hydrospires in *Crotalocrinus* on p. 64, and on p. 83 this is extended into the following generalization:—"The Crotalocrinidæ have no anambulacral pieces, but possess hydrospires within the calyx."

There is no mention of these hydrospires, however, in the subsequent definitions either of *Crotalocrinus* or of *Enallocrinus* in the second section of this part which has just appeared; and it is possible therefore that the authors have already given up their belief in the presence of these organs in the Crotalocrinidæ. But in any case they will no longer be able to refer to this family as Palæocrinoids which "probably have hydrospires within the calyx" *, and to use this supposed fact as an illustration of their theory that Blastoids, Cystids, and Crinoids are so closely linked together that they are not entitled to rank as Classes of Echinoderms equivalent to the Urchins and Starfishes. This point, however, is fully discussed elsewhere †.

BIBLIOGRAPHICAL NOTICES.

Revision of the Palæocrinoidea.—Part III. *Discussion of the Classification and Relations of the Brachiate Crinoids, and Conclusion of the Generic Descriptions.* By Charles Wachsmuth and Frank Springer. Second Section. Extracted from the 'Proceedings of the Academy of Natural Sciences,' March 30, 1886. Philadelphia, 1886. Pp. 195.

We are very glad to welcome the second and concluding section of the Revision of the Palæocrinoidea, Part III., by Messrs. Wachs-

* 'Revision,' part iii. p. 76.

† 'Catalogue of the Blastoidea in the Geological Department of the British Museum (Natural History)" (London, 1886), pp. 113–121.

muth and Springer, the first section of which was reviewed in the March number of this magazine.

The whole work is one of the utmost value to all palæontologists, and will be a lasting monument of patient and persevering industry on the part of the authors during a period of some eight or nine years. They now recognize 156 genera of Palæocrinoids, which include 1276 species; but they express their belief, which most palæontologists will share, that there are still many synonyms to be worked out. On the other hand, they describe themselves as possessing not less than 100 new species, and we are very glad to hear that these "will be described and amply illustrated hereafter in a Monograph on the Palæocrinoidea of North America." We trust that the appearance of this monograph will not be too long delayed, and that it will contain tables or keys which will display the authors' views as to the mutual relations of the various families and genera of Palæocrinoids, including also the forty-nine non-American genera. Tables of this kind are of more use to the average worker than the most elaborate descriptions, and they have the additional advantage of informing the specialist as to the particular structural differences on which the authors rely as characters of systematic value.

This concluding section of the 'Revision' commences with an account of the suborder "Articulata," which comprises the two families Ichthyocrinidæ and Crotalocrinidæ, together with the problematical genus *Cleiocrinus*, Billings. We suspect, however, for reasons given on a previous page *, that whatever be the fate of *Cleiocrinus*, the Crotalocrinidæ will eventually have to be removed from their present association with the Ichthyocrinidæ, though we should not like to say where their ultimate resting-place will be.

The suborder "Inadunata" falls into the two branches, Larviformia and Fistulata. The former contains the four families Haplocrinidæ, Symbathocrinidæ, Cupressocrinidæ, and Gasterocomidæ; and the authors say of the whole group that they "probably possessed hydrospires and hydrospire pores, to connect with the ambulacra" (p. 157). This may perhaps have been the case in *Cupressocrinus*, but we cannot help thinking this statement to be a very rash one as regards the embryonic forms *Allagecrinus* and *Haplocrinus*. When the former genus was established in 1881 † it was made the type of a separate family, distinguished from the Haplocrinidæ by "the inequality in the size of the radials, owing to some of them being axillary," and the family Allagecrinidæ has since been accepted by De Loriol. So far as we are aware there is no other Crinoid known in which the first radials may be axillary; but Wachsmuth and Springer seem to consider this point so unimportant that they make no reference to it whatever outside their generic diagnosis of *Allagecrinus*. They describe the ventral pyramid above the mouth of this type as consisting of anchylosed

* *Anteà*, pp. 397–406.

† Ann. & Mag. Nat. Hist. 1881, ser. 5, vol. vii. p. 292.

calyx-interradials and not of orals, a point upon which we differ from them altogether, as already explained *.

Passing on to the branch "Fistulata," we find that it includes the families Hybocrinidæ, Heterocrinidæ, Anomalocrinidæ, Cyathocrinidæ, Poteriocrinidæ, Belemnocrinidæ, Astylocrinidæ, together with the Encrinidæ, Catillocrinidæ, and Calceocrinidæ. The first of these comprises the three genera *Bærocrinus*, *Hoplocrinus*, and *Hybocrinus*, together with the problematical *Hybocystites*, first described by Wetherby as a Cystid and now regarded by Wachsmuth and Springer as a Crinoid of low organization. The anomalous recurrent ambulacra of this type seem also to occur in two other Trenton Crinoids, *Taxocrinus elegans*, Billings, sp., and *T. lævis*. We regard this observation as a most important and suggestive one, and shall await further information respecting these very early and somewhat generalized forms with no little interest.

Except perhaps for the biserial arms of some species, we do not quite understand the reasons which have induced Messrs. Wachsmuth and Springer to transfer the Encrinidæ to the Palæocrinoidea. Their diagnosis of the family (p. 194) commences as follows:—"Dicyclic. Closely allied to the Poteriocrinidæ, but, *as a rule*, without anal plates." The insertion of the words "*as a rule*"† is somewhat misleading; for it implies that there are some members of the family in which anal plates do occur. But there is no mention of their presence in the authors' diagnosis either of *Encrinus* or of *Dadocrinus*, the only two genera comprised in the family, and, in fact, *they have never been described*; while Wachsmuth and Springer seem to be in no doubt at all about the presence of interradials in *Encrinus*, though they admit that these, "owing to the large size of the articular facets, must have been small at any time, and possibly were absorbed in the adult" (p. 259). It appears to us, however, that the mature *Encrinus* never can have had calyx-interradials of any kind, since there was no room for them. Not only the second and third radials, but also the primary and secondary arm-divisions (when present) were in close lateral contact all round the cup, with their apposed sides flattened against one another, just as in many tropical *Comatulæ*. Even if interradials had been present in earlier life, as in some *Comatulæ*, and subsequently resorbed, as Wachsmuth and Springer believe, they must have been situated above and not between the primary radials, which form a perfectly symmetrical pentagon without any trace of interradials resting upon them. Messrs. Wachsmuth and Springer place under *Erisocrinus* those *Encrinus*-like Palæozoic species "in which a plate of the ventral tube rests upon the radials. In all probability was the latter piece always present in this genus" (p. 255). *Erisocrinus* is one of the two Palæozoic Poteriocrinidæ which come nearest to *Encrinus*; but the American authors regard

* *Anteà*, p. 403. See also Ann. & Mag. Nat. Hist. March 1886, pp. 282–284.

† The *italics* are due to the authors, and not to the reviewer.

it as probable that the posterior radials supported a ventral tube, and this would introduce an asymmetry into the calyx, of which there is no trace whatever in *Encrinus*. This much they admit on p. 230, where they say:—"In the same degree as palæontologically the calyx grows more symmetrical, the ventral sac decreases in size, and probably disappeared entirely in *Encrinus*, which is closely allied to the Poteriocrinidæ." In like manner they describe their specimens of *Stemmatocrinus Trautscholdi* as showing "traces of interradial plates resting against the inner edges of two radials, of which the places of attachment are plainly visible, and detached plates were placed aside of them." (p. 256). These plates, however, are altogether absent in the Encrinidæ, every species of which has the third radial axillary, a character which is very constant among Neocrinoids, and is by no means so in the Poteriocrinidæ, the second being axillary in *Erisocrinus* and *Stemmatocrinus*. Considering these and other points which we are unable at present to discuss, we cannot but feel that Wachsmuth and Springer have not made out their case for the transfer of the Encrinidæ to the Palæocrinoidea. They express themselves as "willing to admit that *Encrinus* constitutes a transition form towards the Neocrinoidea, it is even possible that in the adult the interradials become partly or wholly resorbed, but it is otherwise so closely connected with the Poteriocrinidæ that we must regard it as a Palæocrinoid, or place also the Poteriocrinidæ among the Neocrinoidea" (p. 257). When they shall have discovered that the calyx of *Encrinus* has an azygos side indicating the presence of the ventral tube, which is so characteristic of the Poteriocrinidæ, we shall be more disposed to agree with them. They say on p. 230, "Comparing *Erisocrinus* with *Encrinus*, the only noticeable difference in their fossil state is the presence of a single brachial in the former and two in the latter." But in making this statement they entirely ignore the fact to which they allude on p. 255, viz. that in *Erisocrinus* a plate of the ventral tube rests upon the radials, while nothing of the kind occurs in *Encrinus*; and yet it is almost exclusively upon this point that the whole question turns. Their comparison of *Encrinus* and *Erisocrinus* is also incomplete in another respect. Not only has *Encrinus* three radials and *Erisocrinus* two, but the authors admit, on p. 192, that the two outer radials and the proximal arm-plates of *Encrinus* are respectively united by syzygy. They ought to know, though they seem to be unaware of it, that this is in accordance with a rule "which holds good in almost all the Neocrinoids"*. But they also expressly state on p. 192 that syzygies are not known to occur in the Poteriocrinidæ, and so furnish another argument against their transfer of *Encrinus* to the Palæocrinoids.

The Catillocrinidæ and Calceocrinidæ are two extremely puzzling families, the morphological study of which is beset with the very greatest difficulties. We think, however, that Messrs. Wachsmuth and Springer have successfully overcome many of these difficulties, and that their analyses of the structure of these curious types will be even-

* Report on the 'Challenger' Crinoidea, p. 49.

tually accepted as correct. They have also been remarkably successful in elucidating the structure, and so fixing the systematic position, of that very singular form *Stephanocrinus*, which has been variously referred to the Crinoids, Cystids, and Blastoids. The American authors show, however, by the aid of some unusually perfect material, that it is really a Brachiate Crinoid "with branching biserial arms, given off in a somewhat similar manner as the arms in the Platycrinidæ." We are very glad to find them now admitting that the ventral pyramid above the mouth is composed of orals, and not of calyx-interradials *, and that *Stephanocrinus* is allied to *Allagecrinus* and *Haplocrinus*. But we cannot at all follow the argument by which they endeavour to prove that this oral pyramid is homologous with the central plate which they have discovered in the dome of some specimens of *Haplocrinus mespiliformis*. A full discussion of this question, however, would be impracticable at present; and the same may be said with respect to the concluding "Notes on the Underbasals and Top Stem-joint of Neocrinoidea and Palæocrinoidea." The authors claim that the symmetry of the top stem-joint in the Apiocrinidæ is interradial, and that the family is consequently built upon the plan of dicyclic Crinoids. There is one slight difficulty in the way of this theory. The top stem-joint certainly has interradial angles in somewhat less than half the species of *Millericrinus*; but in *Guettardicrinus*, *Apiocrinus*, and in the majority of the species of *Millericrinus* the angles of this top stem-joint are distinctly radial, and the explanation given of this awkward fact by Messrs. Wachsmuth and Springer is that the plate "attained its radial angles accidentally by adapting its form to the basal concavity, which is naturally angular" (p. 297).

We are certainly somewhat surprised to be told that the structure of the upper stem-joint, which presents itself in two out of the three genera and in the majority of the species of the Apiocrinidæ, and is especially characteristic of this family as distinguishing it from the Pentacrinidæ, is an "accidental" one †. But the authors are thereby enabled to make the generalization on p. 299, "that the top stem-joint is disposed interradially in the Apiocrinidæ, Pentacrinidæ, and Comatulæ, similar to dicyclic Palæocrinoids." The top of the centro-dorsal certainly has interradial angles in the adult *Comatula*; but its angles are radial before the cirri appear, as is permanently the case in *Apiocrinus*, and the symmetry changes when the radials grow faster than the basals and come to rest directly on the centro-dorsal. But we cannot understand in the least how this proves that the *Comatulæ* "are built upon the plan of dicyclic Palæocrinoids;" and considering that in *Pentacrinus* and also in some species of *Millericrinus* the symmetry of the axial canal is interradial, a character which we cannot regard as having been attained "accidentally," we are inclined to believe that of the

* See Ann. & Mag. Nat. Hist. March 1886, p. 282.

† If the basal concavity "naturally" has radial angles, is it not a "natural" and not an "accidental" circumstance that the top stem-joint which occupies this cavity should also have radial angles?

two alternatives suggested by Wachsmuth and Springer on p. 298 the first is preferable, viz. that "the rules which meet with no exception among the Palæocrinoidea, as far as we know, do not hold good for the Neocrinoidea." The American authors, however, elect for their other alternative, and believe that Neocrinoids are really "built upon the plan of dicyclic Crinoids." They are therefore driven to suggest "accidental" causes to explain away facts which do not suit their theory.

At the end of the volume are nearly four pages of additions and corrections which apply to all the three parts of the 'Revision;' and we strongly advise palæontologists who wish to use the work to commence by making the necessary alterations in their copies. If this be neglected they will rise from the perusal of some passages with an impression altogether different from that which the authors meant to convey. This is especially the case in those parts of the book which contain discussions of disputed questions, *e. g.* the systematic position of *Encrinus*, on p. 231, and the composition of the calyx of *Stemmatocrinus*, on p. 255. We cannot but think that the authors would have been spared the necessity of correcting their statements in these and similar instances if they had taken a little more trouble to give exact references to the writings of fellow-workers whom they quote.

This is no doubt an excessively laborious task; but prevention is notoriously better than cure, and there is no more certain means of avoiding misquotation than a free use of exact references. Messrs. Wachsmuth and Springer have, however, largely dispensed with such references, and we could mention several instances in which the accuracy of their statements has suffered in consequence. But this is a matter of more importance to themselves than to any one else; while they have done a most valuable service to their fellow-workers by the preparation of a copious index to all three parts of their 'Revision.' It does not appear in the 'Proceedings of the Philadelphia Academy,' where their work was originally published, but has been inserted at their own expense into the numerous separate copies of the concluding section of the 'Revision' which they have obtained for distribution. The preparation of this index, which occupies thirty-one pages of double columns, must have been a work of immense labour, for which they will receive the heartiest thanks of all students of the Pelmatozoa. The discoverer of a new specific or generic type will now be able to see what names are preoccupied, and he will no longer have any reason for enriching zoological science with new synonyms. That an index of this kind was wanted may be judged from the fact that a new genus *Triacrinus*, with a type species *T. pyriformis*, were described in 1884 by an American palæontologist, who was unaware that not only the generic, but also the specific, name had been preoccupied by Münster in exactly the same connexion as long ago as 1839!

Messrs. Wachsmuth and Springer assure us that their index "contains a complete list of all generic and specific names used in connexion with the Palæocrinoidea" (p. 303). We have certainly

found that it does contain a very large number of the less known names; but we are not a little surprised at the omission of the three species described in 1884 by Ringueberg in the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' the same journal in which the successive parts of the 'Revision' appeared, viz. *Triacrinus pyriformis*, *T. globosus*, and *Eucalyptocrinus inconspectus.* Ringueberg described his new genus *Triacrinus* as allied to *Hybocrinus*; but neither in the section on the Hybocrinidæ nor anywhere else in the third part of the 'Revision' can we find any mention of Ringueberg's genus.

We also miss any reference in the index to *Apiocrinus dipentas*, and likewise to *Isocrinus nobilis* and *Chladocrinus nobilis*, synonyms of the type which Wachsmuth and Springer call *Taxocrinus nobilis*; while the references which are given to two other synonyms of this species (*Poteriocrinus nobilis* and *Forbesiocrinus nobilis*) are both incorrect. It would have been better too if the names *Barrandeocrinus*, *Canistrocrinus*, and *Centrocrinus* had been placed respectively before *Barycrinus*, *Carabocrinus*, and *Ceriocrinus*, instead of after these names.

In spite of these and other errors of detail, however, many of which are no doubt due to the circumstances under which the work was prepared, as hinted on p. 299 of Part III., we have no hesitation in saying that the 'Revision of the Palæocrinoidea' is a memoir of the utmost value and importance. It will be indispensable alike to the morphologist who wishes to study the remarkable Crinoid types which flourished in the Palæozoic seas, and to the pure systematist who desires a natural classification of one of the great groups of Echinoderms—that large subkingdom in the study of which one may find some relief from the everlasting strife about the mutual relations of Worms and Arthropods, Ascidians and Vertebrates, and all the latest productions of the most advanced speculative zoology; while the stratigraphical palæontologist, who wishes to determine the age of a bed by the characters of its fossils, will find in the 'Revision' much food for reflection in the most valuable information respecting transition-forms in Crinoids and their palæontological development through a long series of strata.

P. Herbert Carpenter.

Catalogue of the Blastoidea in the Geological Department of the British Museum (Natural History), with an Account of the Morphology and Systematic Position of the Group, and a Revision of the Genera and Species. By Robert Etheridge, Jun., and P. Herbert Carpenter, D.Sc., F.R.S., F.L.S. 4to. Pp. i–xvi, 1–322; 20 plates. London: Printed by Order of the Trustees, 1886.

A year and a half ago we noticed in this Journal * a very important

* Ann. & Mag. Nat. Hist. ser. 5, vol. xv. p. 346.

work on the Stalked Crinoids *. This monograph, the result of the researches of Dr. P. Herbert Carpenter upon all the known recent species, threw a flood of light upon the morphology of the long array of fossil forms; for although the number of living representatives of the Crinoidea bears only the smallest proportion to those which are extinct, the clue they furnish renders inestimable assistance in the task of elucidating the organization of the primeval members of the race. In comparison, the difficulties that beset the path of the student of a group of animals known only as fossils, and of which no distant relatives whatever have survived to the present day, are immeasurably greater.

We have now received a monograph on the Blastoidea, another group of Echinoderms, and one to which special interest attaches from the fact that the type became altogether extinct before the close of the Palæozoic epoch. Not a single living representative or analogue is known. On this account the Blastoidea are far more difficult to study, and the intricacies of their organization much more perplexing to unravel, than is the case in the kindred class of the Crinoidea.

Owing to the strange human tendency to value most what is rarest and most difficult to attain, the elucidation of the details of Blastoid anatomy has long been a goal towards which the aim of naturalists has been directed. It is somewhat surprising, however, that although many detached observations and descriptions of species have been published, no attempt at a complete monograph of these obscure and imperfectly-known animals has been made since the short but masterly memoir of Dr. Ferd. Roemer † in 1851. Much material and knowledge has been accumulated in the interval.

The present work is the result of seven years' constant and industrious research on the part of Mr. Robert Etheridge, Jun., and Dr. P. Herbert Carpenter. The previous publications of both authors are too well known and appreciated to need recapitulation here, and it may be unhesitatingly affirmed that the present investigation could not have been placed in more competent hands. Mr. Etheridge's extensive knowledge of fossil forms, and his carefully trained and accurate judgment would alone be a sufficient guarantee for the excellency of the work; whilst his association with such a *collaborateur* as Dr. Carpenter, who is without exception the most intimately acquainted with the morphology of recent Crinoids of any living naturalist, is a circumstance something more than fortunate. The result is that a monograph has been produced of which British naturalists may well be proud; and the Trustees of the British Museum are to be congratulated on the acquisition and publication of a most important memoir.

* "Report upon the Crinoidea collected during the Voyage of H.M.S. 'Challenger' during the years 1873–76.—The Stalked Crinoids." By P. Herbert Carpenter, D.Sc. [Report on the Scientific Results of the Voyage of H.M.S. 'Challenger.'—Zoology, part xxxii.] Published by Order of Her Majesty's Government, 1884.

† Archiv f. Naturgesch. 1851, Jahrg. xvii. Bd. i. pp. 323–397, Taf. i.–v.

The authors have been singularly fortunate in having access to an unrivalled series of specimens, the riches of the National Collection having been largely supplemented by the friendly cooperation of many English and foreign palæontologists. Most important assistance has, in this manner, been rendered by Mr. Charles Wachsmuth of Burlington, Iowa, who, with a generosity beyond all praise, unreservedly placed at the disposal of the authors an extremely valuable series of American Blastoids, selected from his own fine collection as especially adapted for the exhibition of structural characters. And it is not too much to say that by means of this friendly help it has been possible to interpret the details of many points of internal structure which could not otherwise have been satisfactorily explained at present.

The first portion of the "Catalogue" is devoted to the morphology of the Blastoids generally. This section of the work is prefaced by the zoological history of the group, and then follows an account of the structure presented by the various forms, each plate and organ being described in detail, their modifications throughout the series reviewed, and their probable functions and homologies discussed. The geological and geographical distribution of the Blastoidea is next treated of. Then follows the systematic portion of the work, in which the species and higher classificatory divisions are clearly defined and severally discussed.

The much controverted question of the relative rank which should be assigned to the Blastoidea among the other groups of Echinoderms is reviewed in a chapter marked by great clearness of judgment and logical reasoning. The authors rank the Blastoidea as a distinct class of the branch Pelmatozoa, which is recognized as a primary division of the Echinodermata, comprising the three equivalent classes Crinoidea, Blastoidea, Cystidea.

The following definition, embracing the result of the authors' long and careful study of the group, will give in their own words a brief conspectus of some of the important results arrived at, which for want of space we are reluctantly unable to notice :—

"Class Blastoidea.

"Armless Pelmatozoa of a pyriform, clavate, ovate, or globose shape, which usually exhibits a very perfect radial symmetry. Base monocyclic, of two large plates and one small one, the latter being always in the left anterior interradius (A–B). Five radials, more or less deeply incised by the ambulacra, and five interradials which rest on them and bound the peristome, one of them being pierced by the anus.

"Ambulacra fringed on each side by a single or double row of jointed appendages, which are in close relation with the side plates. These rest on or against a subambulacral lancet-plate, which is pierced by a canal that lodged the water-vessel and unites with its fellows into a circumoral ring.

"Hydrospires arranged in ten (or rarely eight) groups, which are

limited to the radial and interradial plates; their slits are parallel to, and more or less completely concealed by, the ambulacra, often opening externally through pores at their sides, and also by five or ten openings round the peristome. Neither hydrospires nor ambulacra extend below the basiradial suture.

"Peristome naturally concealed by a vault of small plates, which rarely exhibit any definite arrangement, and are continuous with the covering-plates of the ambulacra."

The authors consider that "the Blastoidea constitute a remarkably compact group which is pretty clearly marked off from the other Pelmatozoa;" and they point out that the perforate lancet-plate and the regular limitation of the hydrospires to the radial and interradial plates, with their slits parallel to the ambulacra (both points of very considerable importance, as well in a morphological as in a physiological aspect), are characters which are not as yet known to occur in either the Crinoidea or the Cystidea.

Two orders, six families, and nineteen genera are defined:—

Order REGULARES, E. & C.

Pedunculate Blastoids with a symmetrical base, in which the radials and ambulacra are all equal and similar.

1st Family. PENTREMITIDÆ, d'Orbigny (emend. E. & C.).

Base usually convex and often much elongated. Spiracles five, but sometimes more or less completely divided by a median septum. Their distal boundary formed by side plates. Hydrospires concentrated at the lowest part of the radial sinus.

Pentremites, Say. *Pentremitidea,* d'Orbigny.
Mesoblastus, E. & C.

2nd Family. TROOSTOBLASTIDÆ, E. & C.

Ambulacra very narrow and descending sharply outwards from the much restricted peristome. Deltoids usually limited to the summit and rarely visible externally. Lancet-plate entirely covered by the side plates. Spiracles generally double, appearing as linear slits at the sides of the deltoid ridge, but not bounded distally by side plates.

Troostocrinus, Shumard. *Metablastus,* E. & C.
Tricœlocrinus, Meek & Worthen.

3rd Family. NUCLEOBLASTIDÆ, E. & C.

Calyx usually globular or ovoidal, with flattened or concave base and linear ambulacra. Spiracles distinctly double, and chiefly formed by the apposition of notches in the lancet-plate and deltoids.

(i.) Subfamily ELÆACRINIDÆ, E. & C.

Elæacrinus, Roemer.

(ii.) Subfamily SCHIZOBLASTIDÆ, E. & C.

Schizoblastus, E. & C. *Cryptoblastus*, E. & C.
Acentrotremites, E. & C.

4th Family. GRANATOBLASTIDÆ, E. & C.

Calyx globular or ovoidal, with flattened or concave base and linear ambulacra. Spiracles five, piercing the deltoids; or ten, grooving their lateral edges.

Granatocrinus, Troost. *Heteroblastus*, E. & C.

5th Family. CODASTERIDÆ, E. & C.

Base usually well developed and sometimes very long. Some, or all of the hydrospire-slits pierce the calyx-plates on the sides of the radial sinus, restricted portions of which may remain open as the spiracles.

(i.) Subfamily PHÆNOSCHISMIDÆ, E. & C.

Codaster, McCoy. *Phænoschisma*, E. & C.

(ii.) Subfamily CRYPTOSCHISMIDÆ, E. & C.

Orophocrinus, von Seebach. *Cryptoschisma*, E. & C.

Order IRREGULARES, E. & C.

Unstalked Blastoids, in which one ambulacrum and the corresponding radial are different from their fellows. Base usually unsymmetrical.

6th Family. ASTROCRINIDÆ, T. & T. Austin
(emend. E. & C.).

(i) Basals unsymmetrical. Azygos radial small and without definite limbs; its ambulacrum short, wide, and horizontal.

Astrocrinus, T. & T. Austin.
Eleutherocrinus, Shumard & Yandell.

(ii) Basals symmetrical; odd ambulacrum linear.

Pentephyllum, Haughton.

The authors state that there is no certain evidence of the existence of true Blastoids anterior to the Upper Silurian period; and the type appears to have become extinct long before the close of the

Carboniferous Series, no trace of Blastoids from the Lower Carboniferous (or Calciferous Sandstone Series), much less from any of the marine bands of the Coal-Measures, being known.

All the known Blastoids of the Upper Silurian period are confined to American strata, and represent the families Troostoblastidæ and Codasteridæ.

In the Devonian period all the families are represented. The Silurian Troostoblastidæ, however, do not appear in the American Devonian rocks; but they are well represented in Europe, although the Devonian Blastoids generally are slightly more numerous both in genera and species in America than in Europe. In Europe the great centre of Blastoid life in Devonian times appears to have been in the north of Spain, whilst in the British Isles there is but the scantiest evidence of their presence in the rocks of that period.

In the Carboniferous period ten genera are represented in Europe (all present in the British Isles), and ten, or possibly twelve, in America.

Pentremitidea, *Elæacrinus*, *Cryptoschisma*, and *Eleutherocrinus* are found only in the Devonian.

Pentremites, *Mesoblastus*, *Tricœlocrinus*, *Cryptoblastus*, *Acentrotremites*, *Heteroblastus*, *Orophocrinus*, *Astrocrinus*, and *Pentephyllum* are found only in the Carboniferous.

Of the remaining six genera, *Troostocrinus*, which appeared in the Silurian, is represented in the Carboniferous by a form which the authors think may probably be referred to it, although the genus has not yet been definitely recognized by them in the Devonian. *Codaster*, which appeared in the Silurian, passes up into the Devonian, and thence into the Carboniferous. *Metablastus*, *Schizoblastus*, and *Granatocrinus*, which occur in the Carboniferous, are represented in the Devonian by forms which the authors provisionally refer to the same genera. *Phænoschisma*, which appeared in the Devonian, passes up into the Carboniferous.

The authors remark that "The distribution of the various species of Blastoids is very limited both in Space and Time. A few species appear to be common to the Upper and Lower Devonian of America; but each of the great divisions of the Subcarboniferous in the Mississippi valley seems to have its own particular types. No Blastoid occurs on both sides of the Atlantic; one species is common to the Devonian of Spain and Germany, and another to the Carboniferous Limestone of Britain and Belgium. But with these exceptions the range of individual specific types is very limited indeed."

A list of the works consulted and a very complete index are given. The plates are most excellent, and, besides possessing great artistic merit, are especially noteworthy for the care with which the magnified details of critical points of structure are rendered.

In according our highest praise to this masterly Catalogue, we would desire to thank the authors for the boon they have conferred upon palæontologists, and also to express the hope that the much-needed monographs of the Crinoidea and Cystidea may be taken in hand by the same able and conscientious workers.

MISCELLANEOUS.

On the Heart, the Digestive Tube, and the Generative Organs of Amarœcium torquatum. By M. C. Maurice.

On examining a transverse section made about the middle of the postabdomen of an *Amarœcium* we find three entirely empty cavities. One of them, which is elongated and median, occupies the whole width of the postabdomen and is situated in the horizontal plane of the Ascidian; of the other two, of irregular form, one is dorsal, the other ventral. These cavities are the sections of three tubes which run longitudinally in the postabdomen; they have been observed in other species of Ascidia by MM. Seeliger, von Drasche, and Della Valle, although these writers were unable to ascertain their precise signification. The last two cavities were regarded by M. Della Valle as processes (peritoneal sacs) of the peribranchial cavity. I have been able, in *Amarœcium torquatum*, to ascertain the anatomical arrangement of these different organs.

At the posterior extremity of the postabdomen the heart is situated. The cardiac cavity, and with it the pericardiac cavity, are incurved in the form of a crescent, one of the horns of which is produced into the dorsal and the other into the ventral half of the postabdomen. The pericardiac cavity ascends very far on each side; each of its branches terminates cæcally at a level which varies in different individuals, but generally at the level of the ovary. These two branches of the pericardiac cavity are the two peritoneal sacs of M. Della Valle mentioned above.

As regards the median tube of the postabdomen, it terminates cæcally posteriorly, after having bifurcated near its extremity into two branches, which nearly reach the end of the postabdomen. If, on the other hand, we trace this tube forward, that is to say towards the viscera, it is seen to subdivide at the level of the stomach into two tubes, which apply their anterior extremities against the bottom of the branchial cavity on each side of the posterior raphe, between the extremity of the endostyle and the entrance of the œsophagus. These anatomical arrangements show that we have here to do with the organ which MM. Van Beneden and Julin have called the *epicardium*, an organ which is a dependency of the branchial sac. In adult individuals I have been unable to demonstrate the actual orifices of the epicardiac tubes into the branchial cavity; but these orifices are evidently closed by secondary obliteration in the course of the development of the animal, for I have found the communications between these tubes and the branchial cavity very distinct in an allied species, *A. proliferum*, and in the young larvæ of the present species, *A. torquatum*.

Thus, of the three cavities which we find in a transverse section of the postabdomen at the middle, the median one is a dependency of the branchial cavity (epicardium) and the other two processes of the pericardiac cavity.

The cardiac cavity is open, not only at its two extremities, as in

the simple and social Ascidia, but throughout its whole length. The cardiac fissure, in fact, is situated upon the convex surface of the crescent formed by the heart; it therefore, as it were, turns its back to the epicardiac sac, which can thus no longer, as in *Clavelina*, be applied to it to close it.

The cells of the cardiac epithelium present a row of muscular fibrillæ towards the cavity of the heart; their nuclei, on the contrary, are situated towards the pericardiac cavity. Neither the vessels nor the heart present any endothelium.

Digestive Tube.—All along the terminal intestine we can very easily see the composite tubular gland which Huxley was the first to indicate in all the groups of the Tunicata, but the existence of which has lately been denied, even in the simple Ascidia. This gland is formed by a quantity of small tubes terminating cæcally, which pour their secretion into the stomach by a common duct.

The anus presents a wide process, which projects into the interior of the cloacal cavity. It is further surrounded by several transverse muscular sphincters.

The cloacal cavity elongates considerably during reproduction, to become transformed into a cavity of incubation in which the embryos are developed. The oviduct, which opened into the cloaca by the side of the deferent canal, takes part in the formation of the incubatory chamber; while the upper lip of its orifice remains applied against the deferent canal, its actual aperture is carried to the very bottom of the incubatory cavity. The cloacal aperture is remarkable for a series of tonguelets or plates, exclusively belonging to the epithelium.

Generative Organs.—These are situated in the postabdomen, on the same side of the epicardiac lamina, in the dorsal face of the animal. The ovary is placed in front of the testis. There is a very distinct oviduct, applied throughout its whole length against the outer surface of the deferent duct; this oviduct is flattened and bounded by an unciliated epithelium, while the deferent duct is rounded and bounded by vibratile epithelium.

The ovary presents a cavity which is continued directly into that of the oviduct; this cavity is bounded by a flat epithelium, which, at certain points, becomes a typical germinative epithelium. It is at the expense of this germinative epithelium that the ovarian follicles are developed; these are never detached from the epithelium from which they originated. The mature ova fall into the ovarian cavity, to be expelled through the oviduct.

The ovary and the testis are never in function at the same time. —*Comptes Rendus*, September 13, 1886, p. 504.

A new Form of Opalina. By M. N. Warpachowsky.

The author describes a new form of parasite which he has met with abundantly in the body-cavity of young earthworms. The animal shows the general characters of *Opalina* and somewhat resembles *Opalina filum*, Clap., in external form; but it is distinguished from all other species of the genus known to the author by

the presence of a long spiculum, on account of which he names it *Opalina spiculata*.

The body is elongate-ovate, somewhat pointed in front; its length is 235–240 μ, and its breadth from 37–38 μ. The whole surface is covered with short cilia, which form regular longitudinal series, and are somewhat longer and more numerous at the anterior end. The nucleus is spindle-shaped and occupies the whole length of the body. Instead of the contractile vacuoles there are several pale vesiculiform nuclei.

The special character of the former consists in a long spiculum, which lies in the interior of the body, and occupies about two thirds of its total length.

A constriction at the hinder part of the body behind the spiculum indicates a new individual; but the formation here of a small spiculum always precedes the production of the divisional groove, so that the spiculum of the parent has absolutely no part in the production of the young. The length of the new *Opalina* thus produced is about 57–58 μ; its form is oval, its nucleus does not occupy the whole length of the body, and the spiculum is only about half that length. The newly formed *Opalinæ* either separate from the parent and swim away, or remain united to it to the number of two, three, or four. By its mode of production the parasite most resembles *O. prolifera*, Clap., by the presence of the spiculum *O. uncinata*, Clap.—*Bull. Acad. Imp. Sci. St. Pétersb.* tom. xxx. pp. 512–514.

A new Gazelle from the Somali-land.
By M. Franz Kohl.

The author describes a new species of gazelle, brought by M. J. Menges from the Somali-land, and of which the museum at Vienna possesses an adult male example.

Gazella Pelzelnii, Kohl (sp. n.).

This new species is most nearly allied to *Gazella arabica*, Lichtenstein (Hempr. & Ehrenb.), as regards both the coloration and the form of the horns. It is somewhat smaller, about the size of a small roe-deer; its head is smaller than in *G. arabica*, and the portion of the skull behind the horns a little longer in proportion. The horns, as in the compared species, are very slender, much longer than the head (27 centim.), but instead of 14–17 have 21 rings, of which, however, the last is very weak and indistinct. In the curvature of the horns the two species are alike; but in *G. Pelzelnii* they diverge much more, so that the distance between the tips is much greater—in *G. arabica* 3″ 6‴–3″ 10‴, in *G. Pelzelnii* 5″ 2‴ (13·6 centim.). Further differences are shown in the proportions of the skull.

Statement of the collector:—Pupil elongate, iris deep dark blue. Collected at Berberah, in the Somali-land, 21st January, 1885.—*Verh. zool.-bot. Gesellsch. in Wien*, Band xxxvi. 1886, *Sitz.* p. 4.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 108. DECEMBER 1886.

H-20

XL.—*Note on* Hesperomys pyrrhorhinus, *Pr. Max.* By Oldfield Thomas, Natural History Museum.

When describing *, in 1882, the very interesting collection of Rodents obtained by M. Stolzmann in North Peru for the Warsaw Museum I identified, although with considerable doubt, two specimens with *Hesperomys pyrrhorhinus*, Pr. Max.†, originally obtained from Bahia, with whose very insufficient description they agreed closely enough for it to be unsafe to describe them as new without seeing Prince Maximilian's typical specimens.

That my doubts as to the correctness of this determination were justified, however, has now been proved by the arrival at the Museum of two young Vesper-mice agreeing so precisely with the description and figure of *H. pyrrhorhinus* that I have no hesitation in referring them to that species.

These specimens were obtained at San Leopoldo, Rio Grande do Sul, by the indefatigable naturalist Dr. Hermann von Ihering, to whom, both as collector and observer, we are indebted for a considerable portion of our knowledge of the mammals inhabiting that region.

* P. Z. S. 1882, p. 98.

† Abbild. Nat. Bras. pl. xxvii. 1822-26; Beitr. ii. p. 422 (1826).

Although these specimens of *H. pyrrhorhinus* are much too young for me to draw up a full account of the species from them, I am yet able to make out that it is certainly a member of the subgenus *Oryzomys*, to which the great mass of Brazilian Vesper-mice also belong. It has rounded hairy ears, without projections, eight mammæ, five interdental palate-ridges, and naked soles with elongated posterior foot-pads. Its molars are of the usual *Oryzomys* pattern, and the length of $m.^1$, which I have had to extract from below the gum, is 2·6 millim.; and therefore, judging roughly by this, the only exact and unchanging measurement available on such young specimens, the species is probably, when fully grown, of about the size of *H. ratticeps*, Hens.*

The true *H. pyrrhorhinus* being thus an *Oryzomys*, M. Stolzmann's Peruvian specimens, although possessing a certain superficial resemblance in size and colour to it, really differ very materially in their essential characters, and I am therefore driven to find a new name for them, there being apparently no other described species to which they can be assigned.

Of the new species, for which I would propose the name of *H. pyrrhonotus*, no further description of the external characters is necessary beyond that already published †; but it may be interesting to note the chief characteristics of its skull. These show it to belong, not to *Rhipidomys*, but to the small group of Peruvian species to which Dr. Coues ‡ has applied the name of *Thomasomys*, although I should have preferred to regard them as aberrant members of *Vesperimus*, to which group I attached them in 1884 §. The skull, as a whole, resembles that of *H. cinereus*, Thos. ‖, both in size and general form. The muzzle is long and slender; the supra-orbital space is narrow and parallel-sided, and its edges square, but smooth and unbeaded; the fronto-parietal sutures meet at a sharp angle in the middle line; the anterior edge of the zygoma-root is vertical and without a projecting plate; the palatine foramina are long and widely open; the bullæ are most unusually large and swollen, exceeding those of any other member of the genus that I have seen. The incisors are very broad and strong, and their anterior surfaces are dark orange, the lower ones being but slightly lighter than the upper; the molars are of the usual pattern, but are much

* Abhandl. Ak. Berl. 1872, p. 36.

† P. Z. S. 1882, p. 107.

‡ Am. Nat. xviii. p. 1275.

§ P. Z. S. 1884, p. 449.

‖ Figured P. Z. S. 1884, pl. xliv. figs. 2–4.

larger in proportion to the size of the animal than those of any of the allied species.

The following are the dimensions of the typical specimen, a female, preserved in spirit:—

Head and body 147 millim., tail 195, hind foot 31, forearm and hand 39·5, ear (above crown) 14.

Skull: basal length 31·5 millim., greatest breadth 20·0; nasals, length 14·0; interorbital constriction, breadth 4·2; interparietal, length 4·8, breadth 11·0; palate, length 17·6; palatal foramen 7·5; length of molar series 7·0; basi-cranial axis 12·0.

As to the other species incidentally mentioned under *H. pyrrhorhinus* in my former paper, I am indebted to Dr. Herluf Winge, of Copenhagen, for such a description of the true *H. mastacalis*, Lund *, as shows that *H. pyrrhonotus* is wholly distinct from that animal; while a personal examination of the type of *H. macrurus*, Gerv. †, in the Paris Museum, proves that, like *H. mastacalis*, it is a true *Rhipidomys*, and differs therefore very essentially from the Peruvian species here described.

XLI.—*A Synopsis of the Reptiles and Batrachians of the Province Rio Grande do Sul, Brazil.* By G. A. Boulenger.

The present list includes all the species of Reptiles and Batrachians hitherto obtained in the Province Rio Grande do Sul. The total numbers (63 for the former and 28 for the latter class, against 31 and 22 as given by Hensel, the first explorer of that district) show an increase almost entirely due to Dr. von Ihering's activity. In view of rendering this list more useful, I have intercalated keys to the genera and species, based on the most constant and easily ascertainable characters, as taken from specimens obtained in the Province, and every species is accompanied by an enumeration of the principal synonyms. The latter part of the work will be found to contain much original matter, especially as I have had access to the entire Henselian collection in the Berlin Museum.

The indication "B. M.; v. I." signifies that specimens have been sent to the Natural-History Museum by Dr. von Ihering.

* Blik Bras. Dyr., Dansk. Afhandl. viii. p. 279 (1841).

† Casteln. Exp. Amér. du Sud, Mamm. p. 3 (1855).

REPTILIA.

Chelonia.

Testudinidæ.

Clemmys, Wagl.

Clemmys Dorbignyi.

Emys Dorbignyi, Dum. & Bibr. Erp. Gén. ii. p. 272; d'Orbigny, Voy. Am. Mér. v., Rept. p. 6, pl. i.

B. M.; v. I. Near Rio Grande.

Chelydidæ.

a. Nuchal plate marginal; a pair of barbels on the chin . . *Platemys.*
b. Nuchal plate simulating a sixth vertebral; no barbels . . *Hydromedusa.*

Platemys, Wagl.

A. Barbels nearly as long as the diameter of the eye, black at the base; upper surface of neck with flat warts; soft parts with dark spots or bands.

a. A broad black band on each side of the head; plastron dirty yellow or brown; carapace with black and yellow lines or vermiculations . . . . *P. Geoffroyana.*
b. A narrow black line on each side of the head; plastron yellow with black spots; carapace uniform olive-brown or with a few black spots . . . . *P. Hilairii.*

B. Barbels very short, smaller than the warts on the upper surface of the neck, which are large, conical, erect; soft parts uniform olive-brown; plastron blackish . . . . *P. Spixii.*

Platemys Geoffroyana.

Emys Geoffreana, Schweigg. Arch. Königsb. i. 1812, p. 302.
Platemys Geoffreana, Dum. & Bibr. *l. c.* p. 418.
Platemys Geoffreyana, part., Hensel, Arch. f. Nat. 1868, p. 350.

B. M.; v. I.

Platemys Hilairii.

Platemys Geoffreana, juv., Dum. & Bibr. *l. c.* p. 421.
Platemys Hilarii, Dum. & Bibr. *l. c.* p. 428; Burmeister, Reise La Plata, ii. p. 521.
Platemys Geoffreyana, part., Hens. *l. c.* p. 350.
Spatulemys Lasalæ, Gray, Ann. & Mag. Nat. Hist. (4) x. 1870, p. 463, and xi. 1871, p. 73, pl. ii.

B. M.; v. I.

Platemys Spixii.

Platemys Spixii, Dum. & Bibr. *l. c.* p. 409.

B. M.; v. I. One example, from San Lorenzo.

Hydromedusa, Wagl.

Hydromedusa tectifera.

Hydromedusa Maximiliani (non Mik.), Wagl. Syst. Amph. p. 135, pl. iii. figs. 25–42; Burmeister, An. Soc. Sc. Argent. xxi. 1886, p. 5.
Chelodina Maximiliani, Dum. & Bibr. *l. c.* p. 449; Hens. *l. c.* p. 355.
Hydromedusa tectifera, Cope, Proc. Am. Phil. Soc xi. 1869, p. 147; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. 1885, p. 85.
Hydromedusa platanensis, Gray, Ann. & Mag. Nat. Hist. (4) xi. 1873, p. 302; Günth. Ann. & Mag. Nat. Hist. (5) xiv. 1884, p. 423, pl. xiv.
Hydromedusa Wagleri, Günth. *l. c.*

B. M.; v. I.

Chelonidæ.

Thalassochelys, Fitz.

Thalassochelys caretta.

Testudo caretta, Linn. S. N. i. p. 351.
Testudo caouana, Daud. Rept. ii. p. 54.
Chelonia caouana, Dum. & Bibr. ii. p. 552.
Thalassochelys caretta, Bonap. Amph. Eur. p. 24.

B. M.; v. I.

Crocodilia.

Alligator, Cuv.

Alligator latirostris.

Crocodilus yacare, Daud. Rept. ii. p. 407.
Crocodilus latirostris, Daud. *l. c.* p. 417.
Alligator cynocephalus, Dum. & Bibr. iii. p. 86.
Alligator latirostris, Hens. *l. c.* p. 348.

B. M.; v. I.

Lacertilia.

Iguanidæ.

A. A transverse gular fold.

a. A slight dorsal crest or denticulation; dorsal scales uniform .... *Enyalius.*
b. No crest; dorsal lepidosis heterogeneous .... *Anisolepis.*
c. No crest; dorsal scales uniform, granular .... *Urostrophus.*

B. No gular fold.

a. Ventral scales smooth; male with anal pores .... *Liolæmus.*
b. Ventral scales keeled; no anal pores .... *Saccodeira.*

Enyalius, Wagl.

Enyalius Iheringii.

Enyalius Iheringii, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. 1885, p. 192, and Cat. Liz. ii. p. 120, pl. vii.

B. M.; v. I.

Anisolepis, Blgr.

Anisolepis undulatus.

Læmanctus undulatus, Wiegm. Herp. Mex. p. 46.
Læmanctus obtusirostris, Wiegm. *l. c.*
Anisolepis Iheringii, Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. 1885, p. 85, and Cat. Liz. ii. p. 122, pl. ix. fig. 3.
Enyalius undulatus, Bouleng. Cat. p. 121.

Wiegmann's types, which had never received a proper description, have been examined by me in the Berlin Museum, and have led to the above identification.

B. M.; v. I.

Urostrophus, D. & B.

Urostrophus Vautieri.

Urostrophus Vautieri, Dum. & Bibr. Erp. Gén. iv. p. 78, pl. xxxvii. fig. 1; Hensel, *l. c.* p. 348; Bouleng. Cat. Liz. ii. p. 123.

B. M.; v. I

Liolæmus, Gray.

Liolæmus occipitalis.

Liolæmus occipitalis, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. 1885, p. 192, and Cat. Liz. ii. p. 156, pl. x. fig. 3.

B. M.; v. I.

Saccodeira, Gir.

Saccodeira azurea.

Tropidocephalus azureus, F. Müller, Verh. nat. Ges. Basel, vii. 1882, p. 160, pl. —.
Liolæmus azureus, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 192.
Saccodeira azurea, Bouleng. Cat. Liz. ii. p. 160.

B. M.; v. I.

Anguidæ.

Ophiodes, Wagl.

Ophiodes striatus.

Pygopus striatus, Spix, Spec. nov. Lac. Bras. p. 25, pl. xxviii. fig. 1.
Pygopus cariococca, Spix, *l. c.* p. 26, fig. 2.

Ophiodes striatus, Wagl. Isis, 1828, p. 740; Dum. & Bibr. v. p. 789; Hensel, *l. c.* p. 346; Bouleng. Cat. Liz. ii. p. 296.
Pygodactylus Gronovii, Wagl. *l. c.* p. 741.

B. M.; v. I.

Teiidæ.

A. Dorsal scales small, juxtaposed.

a. Ventrals small, forming more than 20 longitudinal series; toes five .... *Tupinambis.*
b. Ventrals in 8 to 12 longitudinal rows; toes five .... *Cnemidophorus.*
c. Ventrals in 8 or 10 longitudinal series; toes four.... *Teius.*

B. Dorsal scales large, imbricate, strongly keeled.... *Pantodactylus.*

Tupinambis, Daud.

Tupinambis teguixin.

Lacerta teguixin, Linn. S. N. i. p. 368.
Teius teguixin, Gray, Ann. Nat. Hist. i. p. 276.
Salvator Merianæ, Dum. & Bibr. v. p. 85.
Podinema teguixin, Hens. *l. c.* p. 347.
Tupinambis teguixin, Bouleng. Cat. Liz. ii. p. 335.

B. M.; v. I.

Cnemidophorus, Wagl.

Cnemidophorus lacertoides.

Cnemidophorus lacertoides, Dum. & Bibr. v. p. 134; Bouleng. Cat. Liz. ii. p. 373.
Cnemidophorus grandensis, Cope, Proc. Amer. Phil. Soc. xi. 1869, p. 158.

Fide Cope, *l. c.*

Teius, Merr.

Teius teyou.

Lacerta teyou, Daud. Rept. iii. p. 195.
Teius viridis, Merr. Tent. p. 60.
Teius teyou, Fitz. N. Class. Rept. p. 51; Bouleng. Cat. Liz. ii. p. 379.
Acrantus viridis, Wagl. Syst. Amph. p. 154; Dum. & Bibr. v. p. 143; Hens. *l. c.* p. 347.
Acrantus teyou, Gray, Cat. Liz. p. 23.
Ameiva cœlestis, d'Orb. Voy. Amér. Mér., Rept. p. 2, pl. v. figs. 1–5.

B. M.; v. I.

Pantodactylus, D. & B.

Pantodactylus Schreibersii.

Cercosaura Schreibersii, Wiegm. Herp. Mex. p. 10.
Pantodactylus Dorbignyi, Dum. & Bibr. v. p. 431.

Cercosaura (Pantodactylus) Schreibersii, Peters, Abh. Berl. Ac. 1862, p. 182, pl. i. fig. 4.
Pantodactylus Schreibersii, Hens. *l. c.* p. 347; Bouleng. Cat. Liz. ii. p. 388.
Pantodactylus bivittatus, Cope, Proc. Ac. Philad. 1863, p. 103.

B. M.; v. I.

Amphisbænidæ.

a. Snout rounded .... *Amphisbæna.*
b. Snout strongly compressed, sharp-edged .... *Anops.*

Amphisbæna, L.

a. Suture between the nasals at least one third as long as that between the præfrontals; second and third upper labials in contact with the ocular .... *Darwinii.*
b. Suture between the nasals not one third as long as that between the præfrontals; second labial in contact with the ocular .... *Mildei.*

Amphisbæna Darwinii.

Amphisbæna Darwinii, Dum. & Bibr. v. p. 490; Peters, Mon. Berl. Ac. 1878, p. 781, pl. —. fig. 6; Strauch, Mél. Biol. Ac. St. Pétersb. xi. p. 403; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 296, and Cat. Liz. ii. p. 442.
Amphisbæna camura, Cope, Proc. Ac. Philad. 1862, p. 350.
Amphisbæna vermicularis (non Wagl.), Hens. *l. c.* p. 339.
Amphisbæna heterozonata, Burm. Reise La Plata, ii. p. 527.
Amphisbæna trachura, Cope, Proc. Am. Phil. Soc. xxii. 1885, p. 187.
Aporarchus prunicolor, Cope, *l. c.* p. 189.

B. M.; v. I.

Amphisbæna Mildei.

Amphisbæna Mildei, Peters, Mon. Berl. Ac. 1878, p. 779, pl. —. fig. 3; Strauch, *l. c.* p. 395.

Porto Alegre. Berlin Mus.

Anops, Bell.

Anops Kingii.

Anops Kingii, Bell, Proc. Zool. Soc. 1833, p. 99, and Zool. Journ. v. 1834, p. 391, pl. xvi. fig. 1; Bouleng. Cat. Liz. ii. p. 451.
Amphisbæna Kingii, Dum. & Bibr. v. p. 476; Hens. *l. c.* p. 343; Strauch, *l. c.* p. 418.

B. M.; v. I.

Scincidæ.

Mabuia, Fitz.

Mabuia dorsivittata.

Mabuia dorsivittata, Cope, Proc. Ac. Philad. 1862, p. 350; Bocourt,

Miss. Sc. Mex., Rept. p. 407, pl. xxii. c. fig. 2; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 87.

Euprepes (*Mabuia*) *virgatus*, Peters, Mon. Berl. Ac. 1874, p. 627.

? *Mabuia Joberti*, Thomin. Bull. Soc. Philom. (7) viii. 1884, p. 148.

Mabuia tetratænia, Boettg. Zeitschr. f. Naturw. lviii. 1885, p. 227.

B. M.; v. I.

Ophidia.

Colubridæ.

I. A single shield between the nasal and the eye; a pair of internasals; eye small, with round pupil; tail very short.

a. No grooved fangs; a pair of præfrontals, in contact with the eye; anal single .... *Geophis.*

b. Grooved fangs present; a single præfrontal, separated from the eye by a præocular; anal divided. *Elapomorphus.*

II. Loreal and præocular shields present *; a pair of internasals; pupil round.

A. No grooved fangs; maxillary teeth equal or subequal.

a. Nostril pierced in a single nasal; tail not one fourth of the total length .... *Ablabes.*

b. Nostril between two nasals; tail not one third of the total length; scales smooth; eye moderate .. *Coronella.*

c. Nostril between two nasals; tail not one third of the total length; scales smooth; eye large...... *Ptyas.*

d. Nostril between two nasals; tail not one third of the total length; scales keeled; side of belly angular .... *Spilotes.*

e. Nostril between two nasals; tail more than one third of the total length .... *Herpetodryas.*

B. No grooved fangs; posterior maxillary teeth much enlarged and separated from the others by an interval.

a. Tail not more than one fourth of the total length; snout and scales normal .... *Liophis.*

b. Tail more than one fourth of the total length...... *Dromicus.*

c. Tail short; dorso-lateral scales narrow, diagonal .. *Xenodon.*

d. Tail short; snout pointed, turned up; rostral shield keeled above.............................. *Heterodon.*

C. Grooved fangs present.

a. Grooved fangs moderate, not more than twice as long as the solid ones .... *Philodryas.*

b. Grooved fangs very large .... *Tomodon.*

III. A single shield between the nasals; nostrils and eyes turned upwards; latter small, with round pupil .... *Helicops.*

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* Except in *Tomodon dorsatus.*

IV. Pupil vertical.

a. No grooved fangs; scales on the vertebral line larger than the others .... *Leptognathus.*
b. Grooved fangs; scales equal; anal divided........ *Thamnodynastes.*
c. Grooved fangs; scales equal; anal entire .... *Oxyrhopus.*

Geophis, Wagl.

Geophis reticulatus.

Geophis reticulatus, Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. 1885, p. 87.

B. M.; v. I.

Elapomorphus, Wiegm.

Elapomorphus lemniscatus.

Elapomorphus lemniscatus, Dum. & Bibr. vii. p. 840; Jan, Icon. Oph. 14, pl. ii. fig. 3; Bouleng. Ann. & Mag. Nat. Hist. (5) xv. pp. 194 and 321, pl. x., and xvi. p. 296.
Elapomorphus reticulatus, Peters, Mon. Berl. Ac. 1860, p. 518, pl. —. fig. 2.
Elapomorphus Iheringii, Strauch, Mél. Biol. Ac. St. Pétersb. xii. 1885, and Bull. xxix. p. 571.
Phalotris melanopleurus, Cope, Proc. Amer. Phil. Soc. xxii. (1885) p. 189.

B. M.; v. I.

Ablabes, D. & B.

Ablabes Agassizii.

Eirenis Agassizii, Jan, Icon. Oph. 15, pl. v. fig. 3.
Ablabes Agassizii, Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 87.

B. M.; v. I.

Coronella, Laur.

A. Third and fourth upper labials entering the orbit.

a. Three temporals in contact with the outer border of the parietal; ventral shields plumbeous on the sides ...... *pœcilopogon.*
b. Two temporals in contact with the outer border of the parietal; ventrals with black dots on the sides; a round light spot on each parietal close to the median suture .. *Iheringii.*

B. Fourth and fifth upper labials entering the orbit.

a. Pale brown above, with three dark-brown longitudinal bands, the lateral passing through the eye .... *obtusa.*
b. Bluish-olive in spirits, with a more or less distinct brown vertebral band .... *Jægeri.*
c. Brown above, elegantly spotted with black and dotted with yellowish; a series of yellowish spots forming a line on each side of the back .... *anomala.*

Coronella pœcilopogon.

Rhadinæa pœcilopogon, Cope, Proc. Ac. Philad. 1863, p. 100; Günth. Zool. Rec. 1866, p. 125.
Enicognathus elegans, Jan, Arch. per la Zool. ii. 1863, p. 58, and Icon. Oph. 16, pl. i. fig. 3.
Dromicus melanocephalus, Peters, Mon. Berl. Ac. 1863, p. 277.
Coronella pœcilopogon, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. 1885, p. 194.

B. M.; v. I.

Coronella Iheringii.

Coronella Iheringii, Bouleng. *l. c.* p. 194.

B. M.; v. I.

Coronella obtusa.

Rhadinæa obtusa, Cope, Proc. Ac. Philad. 1863, p. 101.
Coronella obtusa, Bouleng. *l. c.* p. 194.

B. M.; v. I.

Coronella Jægeri.

Coronella Jægeri, Günth. Cat. Col. Sn. p. 37.
Liophis (Ophiomorphus) dorsalis, Peters, Mon. Berl. Ac. 1863, p. 283; Hens. *l. c.* p. 325.

B. M.; v. I.

Coronella anomala.

Coronella anomala, Günth. *l. c.* p. 37; Bouleng. *l. c.* p. 194.
Lygophis rutilus, Cope, Proc. Ac. Philad. 1862, p. 80.
Coronella pulchella, Jan, Arch. per la Zool. ii. 1863, p. 48, and Icon. Oph. 17, pl. iii. fig. 4.
Aporophis anomalus, Cope, Proc. Am. Phil. Soc. xvii. 1877, p. 93.

B. M.; v. I.

LIOPHIS, Wagl.

A. Frontal considerably shorter than parietals.

a. Scales in 17 rows; ventrals unspotted, black-edged, numbering 165 to 183 .... *fuscus.*
b. Scales in 19 rows; belly spotted or variegated with black *pœcilogyrus.*

B. Frontal nearly as long as parietals.

a. Back with large dark spots; a light streak on each side of the posterior part of the back .... *almadensis.*
b. No large dorsal spots; no dorso-lateral streak .... *typhlus.*

Liophis fuscus.

Liophis Merremii (non Wied), Jan, Icon. Oph. 17, pl. v.
Liophis Merremii, part., Hensel, *l. c.* p. 324.

Liophis cobella (non L.), Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 194.
Opheomorphus fuscus, Cope, Proc. Am. Phil. Soc. xxii. 1885, p. 190; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 297.

Differs from *L. Merremii* and *L. cobella* in the greater number of ventrals. This and the following species were confounded by Hensel, and are to be found united in the same bottle (no. 6831) in the Berlin Museum.

B. M.; v. I.

Liophis pœcilogyrus.

Coluber pœcilogyrus, Wied, Abbild.
Liophis Merremii, var. *pœcilogyrus*, Dum. & Bibr. v. p. 710.
Liophis reginæ, var. *sublineatus*, Cope, Proc. Ac. Philad. 1860, p. 252.
Liophis reginæ, var. *ornatissima*, Jan, Arch. per la Zool. ii. 1863, p. 296.
Liophis pœcilogyrus, Jan, Icon. Oph. 17, pl. vi. fig. 1.
Liophis reginæ, var. *viridicyanea*, Jan, *l. c.* 18, pl. ii. fig. 1.
Liophis Merremii, part., Hens. *l. c.*
Liophis Merremii, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 194.
Opheomorphus meleagris, Cope, Proc. Am. Phil. Soc. xxii. p. 191.

This form differs from *L. Merremii* and *L. regin* in the number of rows of scales, viz. 19 instead of 17.

B. M.; v. I.

Liophis almadensis.

Natrix almadensis, Wagl. in Spix, Serp. Bras. p. 30, pl. x. fig. 3.
Liophis conirostris, Günth. Cat. Col. Sn. p. 46.
Liophis Wagleri, Jan, Arch. per la Zool. ii. 1863, p. 297, and Icon. Oph. 18, pl. iii. figs. 2, 3.
Liophis almadensis, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 194.
Aporophis conirostris, Cope, Proc. Am. Phil. Soc. xxii. p. 191.

B. M.; v. I.

Liophis typhlus.

Coluber typhlus, Linn. S. N. i. p. 378.
Xenodon typhlus, Schleg. Serp. ii. p. 94; Dum. & Bibr. vii. p. 760.
Liophis typhlus, Jan, Arch. per la Zool. ii. 1863, p. 300, and Icon. Oph. 18, pl. iv. fig. 2.

One specimen, from San Lorenzo, was sent by Dr. v. Ihering.

Dromicus, D. & B.

a. Eight upper labials, fourth and fifth entering the orbit; a pair of yellow lines, separated by three rows of scales, along the back and tail, and extending to the snout .... *flavifrenatus.*
b. Nine upper labials; ventral plates dark-edged .... *melanostigma.*

Dromicus flavifrenatus.

Lygophis flavifrenatus, Cope, Proc. Ac. Philad. 1862, p. 80.
Dromicus amabilis, Jan, Icon. Oph. 24, pl. v. fig. 2.
Aporophis flavifrenatus, Cope, Proc. Am. Phil. Soc. xxii. p. 191.

One specimen, from San Lorenzo, was sent by Dr. v. Ihering.

Dromicus melanostigma.

Natrix melanostigma, Wagl. in Spix, Serp. Bras. p. 17, pl. iv. fig. 2.
Dromicus Pleii (non D. & B.), Günth. Cat. Col. Sn. p. 128.
Dromicus melanostigma, Jan, Icon. Oph. 24, pl. v. fig. 3; Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 195, and xvi. p. 297.
Aporophis cyanopleurus, Cope, Proc. Am. Phil. Soc. xxii. p. 191.

B. M.; v. I.

Ptyas, Fitz.

Ptyas pantherinus.

Coluber pantherinus, Daud. Rept. vi. p. 318; Schleg. Serp. ii. p. 143, pl. v. figs. 13 & 14.
Coryphodon pantherinus, Dum. & Bibr. vii. p. 181; Hens. *l. c.* p. 330; Jan, Icon. Oph. 24, pl. iii. fig. 1.
Pseudoelaps pantherinus, Cope, Proc. Ac. Philad. 1862, p. 349.
Drymobius pantherinus, Cope, Proc. Am. Phil. Soc. xxii. p. 192.
Ptyas pantherinus, Boettg. Zeitschr. f. Naturw. lviii. 1885, p. 233.

B. M.; v. I. One specimen, from Porto Alegre.

Spilotes, Wagl.

Spilotes variabilis.

Coluber variabilis, Wied, Abbild.; Schleg. Serp. ii. p. 149, pl. vi. figs. 1 & 2.
Spilotes variabilis, Dum. & Bibr. vii. p. 220; Hens. *l. c.* p. 330.

B. M.; v. I.

Herpetodryas, Schleg.

Herpetodryas carinatus.

Coluber carinatus, Linn. S. N. i. p. 384.
Herpetodryas carinatus, Schleg. Serp. ii. p. 175, pl. vii. figs. 3–7; Dum. & Bibr. vii. p. 207; Hens. *l. c.* p. 330; Jan, Icon. Oph. 31, pl. ii.

B. M.; v. I.

Xenodon, Schleg.

a. Usually seven upper labials, sixth largest, third and fourth, or fourth only, entering the orbit; three or four postoculars; 19 rows of scales .... *rhabdocephalus.*
b. Eight upper labials, seventh largest, fourth and fifth entering the orbit; two postoculars; 21 rows of scales .... *Neuwiedii.*

Xenodon rhabdocephalus.

Coluber rabdocephalus, part., Wied, Abbild.
Xenodon rhabdocephalus, Schleg. Serp. ii. p. 87, pl. iii. figs. 6 & 7; Günth. Ann. & Mag. Nat. Hist. (3) xii. 1863, p. 353, pl. v. fig. B; Jan, Icon. Oph. 19, pl. iv. fig. 1; Hens. *l. c.* p. 325.
Xenodon rhabdocephalus, part., Dum. & Bibr. v. p. 758.

B. M.; v. I.

Xenodon Neuwiedii.

Coluber rabdocephalus, part., Wied, *l. c.*
Xenodon rhabdocephalus, part., Dum. & Bibr. *l. c.*
Xenodon Neuwiedii, Günth. *l. c.* p. 354, fig. C; Hens. *l. c.* p. 328.

I have examined Hensel's two specimens in the Berlin Museum (6836) and found the identification correct.

HETERODON, Latr.

a. None of the labials touch the orbit .... *Dorbignyi.*
b. Third and fourth labials entering the orbit .... *histricus.*

Heterodon Dorbignyi.

Heterodon Dorbignyi, Dum. & Bibr. vii. p. 772; Hens. *l. c.* p. 329; Jan, Icon. Oph. 48, pl. iii. figs. 3–4.
Lystrophis Dorbignyi, Cope, Proc. Am. Phil. Soc. xxii. p. 193.

B. M.; v. I.

Heterodon histricus.

Heterodon histricus, Jan, Arch. per la Zool. ii. 1863, p. 224, and Icon. Oph. 11, pl. iv. fig. 2.

B. M.; v. I. Two specimens, from Rio Cahy, near S. João de Monte Negro.

PHILODRYAS, Wagl.

A. Scales smooth.

a. Scales in 19 rows; seven upper labials, third and fourth entering the orbit; scales black-edged or with small black spots .... *Schottii.*
b. Scales in 17 rows; seven upper labials, third and fourth entering the orbit; back with three dark longitudinal bands, the median occupying three series of scales...... *tæniatus.*
c. Scales in 19 rows; eight upper labials, fourth and fifth entering the orbit; green above, usually with a reddish-brown vertebral line .... *Olfersii.*

B. Scales keeled; green above .... *æstivus.*

Philodryas Schottii.

Xnodon Schottii, Schleg. Serp. ii. p. 91, pl. iii. figs. 8 & 9.
Dryophylax Schottii, Dum. & Bibr. vii. p. 1118.
Philodryas Schottii, Günth. Cat. Col. Sn. p. 125; Hens. *l. c.* p. 332.

Euophrys modestus, Günth. *l. c.* p. 139, and Ann. & Mag. Nat. Hist. (4) ix. 1872, p. 29.
Pseudophis Schottii, Cope, Proc. Ac. Philad. 1862, p. 348.
Liophis pœcilostictus, Jan, Arch. per la Zool. ii. 1863, p. 189; and Icon. Oph. 13, pl. vi. fig. 2.

B. M.; v. I.

Philodryas tæniatus.

Philodryas tæniatus, Peters, in Hens. *l. c.* p. 331.

The type specimen, in the Berlin Museum, is the only one I have yet seen.

Philodryas Olfersii.

Coluber Olfersii, Licht. Verz. Doubl. Mus. Berl. p. 104.
Coluber pileatus, Wied, Abbild.
Coluber herbeus, Wied, *l. c.*
Philodryas Olfersii, Wagl. Syst. Amph. p. 185; Hens. *l. c.* p. 332.
Herpetodryas Olfersii, Schleg. Serp. ii. p. 183, pl. vii. figs. 14 & 15.
Dryophylax Olfersii, Dum. & Bibr. vii. p. 1109; Jan, Icon. Oph. 49, pl. iii. figs. 2–4.

Philodryas æstivus.

Herpetodryas æstivus, part., Schleg. Serp. p. 186.
Dryophylax æstivus, Dum. & Bibr. vii. p. 1111; Jan, Icon. Oph. 49, pl. iii. fig. 1.
Philodryas æstivus, Günth. Cat. Col. Sn. p. 125.
Philodryas carinatus, Hens. *l. c.* p. 332.
Tropidodryas æstivus, Cope, Proc. Amer. Philos. Soc. xxii. p. 192.

B. M.; v. I.

TOMODON, D. & B.

a. No loreal, the nasal touching the præocular; scales in 17 rows .... *dorsatus.*
b. Loreal present; scales in 19 rows .... *ocellatus.*

Tomodon dorsatus.

Tomodon dorsatus, Dum. & Bibr. vii. p. 934; Jan, Icon. Oph. 19, pl. vi. fig. 1; Hens. *l. c.* p. 325.

B. M.; v. I.

Tomodon ocellatus.

Tomodon ocellatus, Dum. & Bibr. vii. p. 938; Jan, *l. c.* fig. 2.

B. M.; v. I. One specimen, from San Lorenzo.

HELICOPS, Wagl.

Helicops carinicaudus.

Coluber carinicaudus, Wied, Abbild.
Helicops carinicaudus, Wagl. Syst. Amph. p. 170, and Icon. Amph. pl. vii.; Dum. & Bibr. vii. p. 744; Hens. *l. c.* p. 329; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 297.

Homalopsis carinicaudus, Schleg. Serp. ii. p. 350, pl. xiii. figs. 17 & 18.
Helicops infratæniatus, Jan, Arch. per la Zool. iii. 1865, p. 245, and Icon. Oph. 28, pl. iii. fig. 3; Cope, Proc. Amer. Philos. Soc. xxii. 1885, p. 193.
Helicops trivittatus, Cope, Proc. Amer. Philos. Soc. xvii. 1877, p. 92.
Helicops baliogaster, Cope, Proc. Amer. Philos. Soc. xxii. p. 193.

B. M.; v. I.

Leptognathus, D. & B.

a. Loreal shield not touching the eye; scales in 13 rows *Catesbyi.*
b. Loreal shield entering the eye; scales in 15 rows; three upper labials posterior to those which enter the orbit; belly powdered with brown.......... *Mikanii.*
c. Loreal shield entering the eye; scales in 15 rows; two upper labials posterior to those which enter the orbit; belly with large black spots .... *ventrimaculatus.*

Leptognathus Catesbyi.

Dipsas Catesbyi, Schleg. Serp. ii. p. 279, pl. xi. figs. 21–23.
Stremmatognathus Catesbyi, Dum. & Bibr. vii. p. 522.
Leptognathus Catesbyi, Günth. Cat. Col. Sn. p. 180; Cope, Proc. Ac. Philad. 1868, p. 107; Jan, Icon. Oph. 37, pl. ii. fig. 2; Cope, Proc. Amer. Philos. Soc. xxii. p. 193.

Introduced here on the authority of Cope, no specimens having been obtained by Hensel or by Dr. v. Ihering.

Leptognathus Mikanii.

Dipsas Mikanii, Schleg. Serp. ii. p. 277.
Anholodon Mikani, Dum. & Bibr. vii. p. 1165.
Leptognathus Mikanii, Günth. Cat. Col. Sn. p. 178; Cope, Proc. Ac. Philad. 1868, p. 108; Jan, Icon. Oph. 37, pl. vi. fig. 3; Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 195.

B. M.; v. I.

Leptognathus ventrimaculatus.

Leptognathus ventrimaculatus, Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 87.

B. M.; v. I.

Thamnodynastes, Wagl.

a. Scales keeled .... *Nattereri.*
b. Scales smooth .... *strigatus.*

Thamnodynastes Nattereri.

Coluber Nattereri, Mikan, Delect. Faun. Bras.; Wied, Abbild.
Dryophylax Nattereri, Wagl. Syst. Amph. p. 181.
Dipsas Nattereri, Schleg. Serp. ii. p. 290; Dum. & Bibr. vii. p. 1149.
Thamnodynastes Nattereri, Günth. Cat. Col. Sn. p. 164; Hens. *l. c.* p. 332; Jan, Icon. Oph. 39, pl. ii. fig. 3.

B. M.; v. I.

Thamnodynastes strigatus.

Tomodon strigatus, Günth. Cat. Col. Sn. p. 52.
Tachymenis hypoconia, Cope, Proc. Acad. Philad. 1860, p. 247; Günth. Zool. Rec. 1866, p. 126; Cope, Proc. Am. Philos. Soc. xxii. p. 192.
Mesotes obtrusus, Jan, Arch. per la Zool. ii. 1863, p. 96, and Icon. Oph. 18, pl. vi. fig. 1.
Thamnodynastes punctatissimus (non Wagl.), Hens. *l. c.* p. 332.
Thamnodynastes Nattereri, var. *lævis*, Bouleng. Ann. & Mag. Nat. Hist. (5) xv. p. 195.

B. M.; v. I.

OXYRHOPUS, Wagl.

A. Seven upper labials (normally); loreal not or scarcely longer than deep.

a. A whitish blotch covers the occiput and nape .... *clœlia.*
b. Uniform brown or blackish above .... *plumbeus.*

B. Eight upper labials.

a. Blackish above, black-and-yellow spotted inferiorly .... *clathratus.*
b. Above with black cross bands or rhomboidal spots; lower parts yellowish, uniform or brown-dotted .... *petalarius.*

Oxyrhopus clœlia.

Coluber clœlia, Daud. Rept. vi. p. 330, pl. lxxviii.
Lycodon clœlia, part., Schleg. Serp. ii. p. 114.
Brachyruton clœlia, Dum. & Bibr. vii. p. 1007; Jan, Icon. Oph. 35, pl. i. fig. 1.
Oxyrhopus clœlia, Günth. Cat. Col. Sn. p. 189.

B. M.; v. I. One specimen, from near Rio Grande.

Oxyrhopus plumbeus.

Coluber plumbeus, Wied, Abbild.; Schleg. Serp. ii. p. 152, pl. vi. figs. 3 & 4.
Brachyruton plumbeus, Dum. & Bibr. vii. p. 1004; Jan, Icon. Oph. 35, pl. i. fig. 3.
Oxyrhopus plumbeus, Günth. Cat. Col. Sn. p. 189; Cope, Proc. Amer. Philos. Soc. xxii. p. 193.

B. M.; v. I.

Oxyrhopus clathratus.

Oxyrhopus clathratus, Dum. & Bibr. vii. p. 1026; Jan, Icon. Oph. 35, pl. iii. fig. 1.
Oxyrhopus immaculatus (non D. & B.), Hens. *l. c.* p. 333.

Oxyrhopus petalarius.

Coluber petalarius, Linn. S. N. i. p. 387.
Oxyrhopus petalarius, Wagl. Syst. Amph. p. 185; Dum. & Bibr. vii. p. 1033; Hens. *l. c.* p. 333; Jan, Icon. Oph. 36, pl. i. figs. 1 & 2.
Oxyrhopus rhombifer, Dum. & Bibr. p. 1018; Jan, Icon. Oph. 35, pl. v. fig. 2; Cope, Proc. Am. Philos. Soc. xxii. p. 193.
Oxyrhopus subpunctatus, Dum. & Bibr. p. 1016.
Oxyrhopus bipræocularis, Dum. & Bibr. p. 1030.

B. M.; v. I.

Elapidæ.

Elaps, Schn.

a. Black annuli on the body equidistant .... *corallinus.*
b. Annuli in threes .... *lemniscatus.*

Elaps corallinus.

Coluber corallinus, Linn. S. N. i. p. 384.
Elaps corallinus, Wied, Abbild.; Schleg. Serp. ii. p. 440, pl. xvi. figs. 1–3; Dum. & Bibr. vii. p. 1207; Hens. *l. c.* p. 333; Jan, Icon. Oph. 41, pl. vi. figs. 1–3.
Micrurus Spixii, Wagl. in Spix, Serp. Bras. p. 48, pl. xviii.

Elaps lemniscatus.

Coluber lemniscatus, Linn. S. N. i. p. 386.
Elaps lemniscatus, Schn. Hist. Amph. ii. p. 291; Schleg. Serp. ii. p. 444, pl. xiv. figs. 6 & 7; Dum. & Bibr. vii. p. 1217; Hens. *l. c.* p. 333; Jan, Icon. Oph. 42, pl. v. fig. 1.
Elaps altirostris, Cope, Proc. Ac. Philad. 1859, p. 345, and 1862, p. 347.

B. M.; v. I.

Viperidæ.

a. Tail simple .... *Bothrops.*
b. End of tail with horny appendages (rattle) .... *Crotalus.*

Bothrops, Wagl.

a. Scales in 21 to 27 rows on the middle of the body; no bar on the rostral shield .... *diporus.*
b. Scales in 29 or 31 rows on the middle of the body; back with alternating C-shaped black spots; a dark vertical bar on the rostral shield .... *alternatus.*

Bothrops diporus.

Bothrops diporus, Cope, Proc. Ac. Philad. 1862, p. 347; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 88; Bœttg. Zeitschr. f. Naturw. lviii. 1885, p. 239.
Bothrops atrox, part., Hens. *l. c.* p. 334.
Trigonocephalus (Bothrops) pubescens, Cope, Proc. Amer. Philos. Soc. xi. 1869, p. 157.

B. M.; v. I.

Bothrops alternatus.

Bothrops alternatus, Dum. & Bibr. vii. p. 1512, pl. lxxxii. fig. 1; Jan, Icon. Oph. 47, pl. vi. fig. 1; Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 88.
Bothrops atrox, part., Hens. *l. c.*

B. M.; v. I.

Hensel's specimen from Veccaria (Mus. Berl. 6855) belongs to *B. alternatus*; the others, from Porto Alegre (6853–54), to *B. diporus.*

Crotalus, L.

Crotalus horridus.

Crotalus horridus, Linn. S. N. i. p. 372; Wied, Abbild.; Dum. & Bibr. vii. p. 1472; Hens. *l. c.* p. 338; Jan, Icon. Oph. 46, pl. iii. figs. 1 & 2.

BATRACHIA.

Ecaudata.

Engystomatidæ.

Engystoma, Fitz.

Engystoma ovale.

Rana ovalis, Schn. Hist. Amph. p. 13.
Engystoma ovale, Fitz. N. Class. Rept. p. 65; Dum. & Bibr. viii. p. 741; Hens. Arch. f. Nat. 1867, p. 140; Bouleng. Cat. Batr. Ecaud. p. 163.
Oxyrhynchus bicolor (Val.), Guér. Icon. R. A., Rept. pl. xxvii. fig. 2.

B. M.; v. I.

Cystignathidæ.

A. Toes webbed; pupil horizontal.

a. Toes entirely webbed; outer metatarsals separated by web; habit ranoid .... *Pseudis.*
b. Toes webbed at the base; outer metatarsals united; habit stout .... *Ceratophrys.*

B. Toes free.

1. Pupil horizontal.

a. Digits dilated into regular disks; vomerine teeth .. *Hylodes.*
b. Vomerine teeth absent (or situated between the choanæ); tympanum indistinct or hidden .... *Paludicola.*
c. Vomerine teeth situated behind the choanæ; tympanum very distinct.............................. *Leptodactylus.*

2. Pupil vertical .... *Limnomedusa.*

Pseudis, Laur.

Pseudis mantidactyla.

Lysapsus mantidactyla, Cope, Proc. Ac. Philad. 1862, p. 352.
Pseudis mantidactyla, Bouleng. Cat. p. 187, and Ann. & Mag. Nat. Hist. (5) xi. 1883, p. 17.
? *Pseudis paradoxa*, Cope, Proc. Amer. Philos. Soc. xxii. (1885) p. 187.

B. M.; v. I.

Ceratophrys, Wied.

a. Upper eyelid with several pointed papillæ; a large bony swelling on each side of the crown................ *bigibbosa.*
b. Upper eyelid produced into a horn-like appendage; a bony dorsal shield .... *dorsata.*
c. Upper eyelid simple; inner metatarsal tubercle sharp-edged; no dorsal shield .... *americana.*

Ceratophrys bigibbosa.

Ceratophrys Boiei (non Wied), Hens. *l. c.* p. 121.
Ceratophrys bigibbosa, Peters, Mon. Berl. Ac. 1872, p. 204; Bouleng. Cat. p. 222.

The unique specimen, preserved in the Berlin Museum, is a male, and probably adult.

Ceratophrys dorsata.

Rana cornuta (non L.), Tilesius, Mag. naturf. Fr. Berl. iii. p. 90, pl. iii.
Ceratophrys dorsata, Wied, Abbild.; Wagl. Icon. Amph. pl. xxii.; Dum. & Bibr. viii. p. 431; Bouleng. Cat. p. 225.

B. M.; v. I.

Ceratophrys americana.

Pyxicephalus americanus, Dum. & Bibr. viii. p. 446; d'Orb. Voy. Amér. Mér. v. p. 10, pl. xiv. figs. 1–4; Hens. *l. c.* p. 123.
Ceratophrys americana, Bouleng. Cat. p. 226.

B. M.; v. I.

HYLODES, Fitz.

Hylodes griseus.

Hyla grisea, Hallow. Proc. Ac. Philad. 1860, p. 485.
Hylodes griseus, Cope, Proc. Ac. Philad. 1863, p. 48; Steindachn. Verh. zool.-bot. Ges. Wien, 1864, p. 245, pl. xvii. fig. 2; Bouleng. Cat. p. 206.
Hylodes, sp., Hens. *l. c.* p. 161.
Hylodes Henselii, Peters, Mon. Berl. Ac. 1870, p. 648.

PALUDICOLA, Wagl.

A. A tubercle on the inner side of the tarsus.
1. Metatarsal tubercles large, compressed, nearer to each other than to the tarsal tubercle.
a. A large lumbar gland; metatarsal tubercles sharp-edged .... *fuscomaculata.*
b. No distinct lumbar gland; metatarsal tubercles blunt *albifrons.*
2. Metatarsal tubercles small, oval or subconical.
a. Metatarsal tubercles nearer to each other than to the tarsal tubercle .... *gracilis.*
. The distance between the tarsal and inner metatarsal tubercles is less than that between the two metatarsal tubercles .... *Henselii.*
B. No tarsal tubercle, but a strong tarsal fold........ *falcipes.*

Paludicola fuscomaculata.

Liuperus marmoratus (non D. & B.), Burm. Reise La Plata, ii. p. 532.
Eupemphix fuscomaculatus, Steind. Verh. zool.-bot. Ges. Wien, 1864, p. 272, pl. xiii. fig. 3.
Gomphobates fuscomaculatus, Steind. Novara, Amph. p. 12.

Lystris fuscomaculatus, Cope, Proc. Ac. Philad. 1868, p. 312.
Pleurodema granulosum, Espada, Viaj. Pacif., Vert. p. 95, pl. i. fig. 6.
Paludicola fuscomaculata, Bouleng. Cat. p. 233, and Ann. & Mag. Nat. Hist. (5) xvi. p. 88; Bœttg. Zeitschr. f. Naturw. lviii. p. 243.

B. M.; v. I.

Paludicola albifrons.

Bufo albifrons, Spix, Test. Ran. Bras. p. 48, pl. xix. fig. 2; Peters, Mon. Berl. Ac. 1872, p. 222.
Paludicola albifrons, Wagl. Syst. Amph. p. 206.
Gomphobates marmoratus, Reinh. & Lütk. Vidensk. Medd. 1861, p. 175, pl. iv. fig. 4; Hens. *l. c.* p. 137; Bouleng. Cat. p. 234.
Eupemphix Nattereri, part., Steind. Verh. zool.-bot. Ges. Wien, 1864, p. 271.

Paludicola gracilis.

Gomphobates notatus (non R. & L.), Hens. *l. c.* p. 138.
Paludicola gracilis, Bouleng. Ann. & Mag. Nat. Hist. (5) xi. 1883, p. 17; Bœttg. Zeitschr. f. Naturw. lviii. p. 244.
Paludicola ranina, Cope, Proc. Amer. Philos. Soc. xxii. p. 186.

B. M.; v. I.

Paludicola Henselii.

Gomphobates Kröyeri (non R. & L.), Hens. *l. c.* p. 139.
Paludicola Henselii, Peters, Mon. Berl. Ac. 1872, p. 223; Bouleng. Cat. p. 235.

Paludicola falcipes.

Liuperus falcipes, Hens. *l. c.* p. 236.
Paludicola falcipes, Bouleng. Cat. p. 236.

B. M.; v. I.

LEPTODACTYLUS, Fitz.

a. Toes without dermal margins; hind limb very long, the tibio-tarsal articulation reaching beyond the tip of the snout .... *gracilis.*
b. Toes without dermal margins; tibio-tarsal articulation not reaching the eye .... *mystacinus.*
c. Toes with dermal margins; tibio-tarsal articulation reaching the eye .... *ocellatus.*

Leptodactylus gracilis.

Cystignathus gracilis, Dum. & Bibr. viii. p. 406; d'Orb. Voy. Amér. Mér. v. p. 10, pl. xiii. figs. 5-7; Hens. *l. c.* p. 130.
Leptodactylus gracilis, Espada, Viaj. Pacif., Vert. p. 44; Bouleng. Cat. p. 241, and Ann. & Mag. Nat. Hist. (5) xiv. 1884, p. 389.

B. M.; v. I.

Leptodactylus mystacinus.

Cystignathus Schomburgkii (non Trosch.), Günth. Cat. Batr. Sal. p. 29.
Cystignathus mystacinus, Burm. Reise La Plata, ii. p. 532.

Cystignathus mystaceus, Hens. *l. c.* p. 125.
Leptodactylus Wuchereri, Espada, *l. c.* p. 68.
Leptodactylus mystacinus, Bouleng. Cat. p. 244.

B. M.; v. I.

Leptodactylus ocellatus.

Rana ocellata, Linn. S. N. i. p. 356.
Rana pachypus, Spix, Test. Ran. Bras. p. 26, pl. ii.
Cystignathus pachypus, Wagl. Icon. Amph. pl. xxi.
Cystignathus ocellatus, part., Dum. & Bibr. viii. p. 396.
Cystignathus ocellatus, Hens. *l. c.* p. 123.
Leptodactylus ocellatus, Girard, Proc. Ac. Philad. 1853, p. 420; Bouleng. Cat. p. 247.
Leptodactylus serialis, Gir. *l. c.* p. 421.
Cystignathus caliginosus (non Gir.), Burm. *l. c.* p. 532.
Leptodactylus pachypus, Espada, *l. c.* p. 48.

B. M.; v. I.

LIMNOMEDUSA, Cope.

Limnomedusa macroglossa.

Cystignathus macroglossus, Dum. & Bibr. viii. p. 405.
Limnomedusa macroglossa, Cope, Journ. Ac. Philad. vi. 1866, p. 94, and Proc. Amer. Philos. Soc. xi. 1869, p. 168; Bouleng. Cat. p. 250, and Ann. & Mag. Nat. Hist. (5) xvi. p. 88.
Litopleura maritimus, Espada, Viaj. Pacif., Vert. p. 82.

B. M.; v. I.

Bufonidæ.

BUFO, Laur.

A. Jaws normal.

a. Parotoids narrow, elongate, pointed behind; tarso-metatarsal articulation not reaching the eye .... *arenarum.*
b. Parotoids enormous .... *marinus.*
c. Parotoids moderate, elongate; tarso-metatarsal articulation reaching in front of the eye, or beyond .... *crucifer.*

B. Edge of the upper jaw dilated horizontally; cranial ridge very strong; parotoids very small, round or subtriangular .... *Dorbignyi.*

Bufo arenarum.

Bufo arenarum, Hens. *l. c.* p. 148; Bouleng. Cat. p. 314, and Ann. & Mag. Nat. Hist. (5) xiv. 1884, p. 389.
Bufo mendocinus, Philippi, Arch. f. Nat. 1869, p. 44.
Bufo marinus, var. *platensis*, Espada, Viaj. Pacif., Vert. p. 202.

B. M.; v. I.

Bufo marinus.

Rana marina, Linn. S. N. i. p. 356.
Bufo marinus, Schneid. Hist. Amph. p. 219; Bouleng. Cat. p. 315.

Bufo agua, Daud. Rain. p. 99, pl. xxxvii.; Spix, Test. Ran. Bras. p. 44, pl. xv.; Wied, Abbild.; Dum. & Bibr. viii. p. 703; Hens. *l. c.* p. 141.
Bufo horridus, Daud. *l. c.* p. 97.
Bufo humeralis, Daud. Rept. viii. p. 205.
Bufo maculiventris, Spix, *l. c.* p. 43, pl. xiv. fig. 1.
Bufo ictericus, Spix, *l. c.* p. 44, pl. xvi. fig. 1.
Bufo lazarus, Spix, *l. c.* p. 45, pl. xvii. fig. 1.
Phrynoidis agua, Cope, Proc. Ac. Philad. 1863, p. 357.

B. M.; v. I.

Bufo crucifer.

Bufo crucifer, Wied, Reise Bras. ii. p. 132; Peters, Mon. Berl. Ac. 1872, p. 221; Bouleng. Cat. p. 316.
Bufo ornatus, Spix, *l. c.* p. 45, pl. xvi. fig.; Wied, Abbild.; Hens. *l. c.* p. 147.
Bufo dorsalis, Spix, *l. c.* p. 46, pl. xvii. fig. 2; Hens. *l. c.* p. 144.
Bufo scaber, Spix, *l. c.* p. 47, pl. xx. fig. 1.
Bufo cinctus, Wied, Abbild.
Bufo melanotis, Dum. & Bibr. viii. p. 710; Hens. *l. c.* p. 148.
Bufo gracilis, Girard, Proc. Ac. Philad. 1853, p. 424.
Phrynoidis ornatus, Cope, *l. c.*
Bufo levicristatus, Bœttg. Zeitschr. f. Naturw. lviii. 1885, pp. 246, 637.

B. M.; v. I.

Bufo Dorbignyi.

Bufo Dorbignyi, Dum. & Bibr. viii. p. 697; d'Orb. Voy. Amér. Mér. v. pl. xv. figs. 5–7; Hens. *l. c.* p. 141; Bouleng. Cat. p. 322.
Chilophryne Dorbignyi, Espada, *l. c.* p. 188.

B. M.; v. I.

Hylidæ.

a. Pupil horizontal; toes free .... *Thoropa.*
b. Pupil horizontal; toes webbed .... *Hyla.*
c. Pupil vertical; fingers and toes free, inner opposable *Phyllomedusa.*

Thoropa, Cope.

Thoropa miliaris.

Rana miliaris, Spix, Test. Ran. Bras. p. 30, pl. vi. fig. 1.
Ololygon abbreviatus, Steind. Novara, Amph. p. 65, pl. iv. figs. 16–18.
Hylodes abbreviatus, Hens. *l. c.* p. 151.
Ololygon miliaris, Peters, Mon. Berl. Ac. 1872, p. 206.
Thoropa miliaris, Bouleng. Cat. p. 331.

Hyla, Laur.

A. Outer fingers at least one-third webbed.
a. Vomerine teeth forming a ∩- or \-shaped figure .... *faber.*
b. Vomerine teeth in a transverse series .. .. *mesophæa.*

B. Outer fingers free or webbed at the base.
1. The distance between the eye and the nostril exceeds the diameter of the eye.
a. Throat smooth .... *rubra.*

. Throat granular; skin tuberculous above; hinder side of thighs marbled with dark brown .... *nasica.*

2. The distance between the eye and the nostril hardly equals the diameter of the eye.

a. Groin and sides of thighs with black spots or bars ...... *pulchella.*
b. Hinder side of thighs uniform or with small white spots *Guentheri.*

Hyla faber.

Hyla faber, Wied, Reise n. Bras. ii. p. 249, and Abbild.; Peters, Mon. Berl. Ac. 1872, p. 218; Bouleng. Cat. p. 351.
Hyla geographica, var. sive *semilineata*, Spix, Test. Ran. Bras. p. 40, pl. xi. fig. 2.
Hypsiboas faber, Wagl. Syst. Amph. p. 200.
Hyla palmata, part., Dum. & Bibr. viii. p. 545.
Hyla palmata, Burm. Erläuter. p. 102.
Hyla maxima (non Laur.), Günth. Cat. Batr. Sal. p. 99; Hens. *l. c.* p. 156.

B. M.; v. I.

? *Hyla mesophæa.*

Hyla leucophyllata (non Beir.), Burm. Erläuter. p. 104, pl. xxxi. fig. 1.
Hyla mesophæa, Hens. *l. c.* p. 154; Peters, Mon. Berl. Ac. 1872, p. 772; Bouleng. Cat. p. 366.

It is not certain whether this species occurs in the province, Hensel not having indicated the locality whence his specimen was obtained.

Hyla rubra.

Hyla rubra, Daud. Rain. p. 26, pl. ix.; Dum. & Bibr. viii. p. 592; Bouleng. Cat. p. 403.
Hyla lateristriga, Spix, Spec. Nov. Test. Ran. p. 32, pl. vi. fig. 4.
Hyla cærulea, Spix, *l. c.* p. 37, pl. x. fig. 1.
Hyla x-signata, Spix, *l. c.* p. 40, pl. xi. fig. 3.
Hyla cynocephala, Dum. & Bibr. p. 558.
Hyla conirostris, Peters, Mon. Berl. Ac. 1863, p. 464.
Scytopis cryptanthus, Cope, Proc. Ac. Philad. 1874, p. 123.

B. M.; v. I. One specimen, from near Rio Grande.

Hyla nasica.

Hyla nasica, Cope, Proc. Ac. Philad. 1862, p. 354; Bouleng. Cat. p. 376.
Hyla Vauterii (non Bell), Hens. *l. c.* p. 157.
Hyla granulata, Peters, Mon. Berl. Ac. 1871, p. 651.

B. M.; v. I.

Hyla pulchella.

Hyla pulchella, Dum. & Bibr. viii. p. 588; Steind. Verh. zool.-bot. Ges. Wien, 1864, p. 241, pl. xi. fig. 2; Bouleng. Cat. p. 375, and Ann. & Mag. Nat. Hist. (5) xvi. p. 298.
Hyla Vauterii, Bell, Zool. 'Beagle,' Rept. p. 45, pl. xix. fig. 2; Bouleng. Cat. p. 376.

Hyla agrestis, Bell, *l. c.* p. 46, pl. xix. fig. 3.
Hyla prasina, Burm. Erläuter. p. 106, pl. xxxi. fig. 2.
Hyla lateralis, Raddi, Mem. Soc. Ital. xix. p. 76.
Hyla rubicundula (non Reinh. & Lütk.), Hens. *l. c.* p. 158.
Hyla bracteator, Hens. *l. c.* p. 159.

B. M.; v. I.

Hyla Guentheri.

Hyla leucotænia (non Burm.), Günth. Proc. Zool. Soc. 1868, p. 489, pl. xl. fig. 4.
Hyla bracteator (non Hens.), Bouleng. Cat. p. 395, and Ann. & Mag. Nat. Hist. (5) xv. p. 196.

B. M.; v. I.

PHYLLOMEDUSA, Wagl.

Phyllomedusa Iheringii.

Phyllomedusa Iheringii, Bouleng. Ann. & Mag. Nat. Hist. (5) xvi. p. 88.

B. M.; v. I.

APODA.

CHTHONERPETON, Ptrs.

Chthonerpeton indistinctum.

Siphonops indistinctus, Reinh. & Lütk. Vidensk. Medd. 1861, p. 203; Hens. *l. c.* p. 162.
Chthonerpeton indistinctum, Peters, Mon. Berl. Ac. 1879, p. 940; Bouleng. Cat. Batr. Caud. p. 104.

XLII.—*Supplement to the Descriptions of Mr. J. Bracebridge Wilson's Australian Sponges.* By H. J. CARTER, F.R.S. &c.

[Plate X.]

[Concluded from p. 379.]

Order VI. HOLORHAPHIDOTA.

Reniera vasiformis, n. sp.

Vasiform, infundibular; wall thin, margin round, uneven, sloped out on one side, truncated (? by the dredge) at the bottom, where the point of attachment is solid. Consistence fragile. Colour light fawn. Surface more or less even generally, but smoother and more cribrate externally than internally. Pores on the outside. Vents numerous, chiefly scattered over the upper and inner side of the margin. Structure fragile, presenting in a vertical section the plumose arrangement generally seen in thin-walled sponges, where the fibres are directed upwards and outwards curvedly from

the axis to the surface on each side, traversed by the canals of the excretory system. Spicules of one form only, viz. acerate, fusiform, curved, sharp-pointed, about 60 by 3-6000ths in., arranged fascicularly. Size of specimen about 3 in. high and 3½ in. across the brim, cup 2½ in. deep, wall in its thickest part about ¼ in.

Loc. Port Phillip Heads.

Obs. This specimen is very like Bowerbank's figures of his *Isodictya infundibuliformis* (B. S. vol. iii. pl. liv.); but I could see no acuate spicules among the acerates of the Australian species.

PHLŒODICTYINA.

There are several fragments of the tubular appendages of Bowerbank's Australian form of *Desmacidon Jeffreysii* (*Oceanapia*, Norman), viz. *D. fistulosa*, Bk. (Proc. Zool. Soc. 1873, p. 19, pl. iv. figs. 7 and 8), but no entire specimen, together with a thick fragment in which several tubes appear to be joined together longitudinally, hence might be termed provisionally:—

Phlœodictyon cohærens.

This fragment, which is cylindrical, consists of the free end of a portion 2½ in. long by 1¼ in. in diameter at the base, which is truncated, diminishing slightly towards the free end, which is round, flat, and obtuse; the truncated end presents a septate structure composed of about twenty tubes, large and small, in juxtaposition, and these, much diminished in calibre, present themselves in the form of as many circular holes or vents at the free end, which is thus rendered cribriform, like the top of a "pepper-box;" hence the structure, instead of being a simple single tube as in *Desmacidon fistulosa*, is a composite one in which many tubes cohere together like a gun with a plurality of barrels. In other respects the structure is just like that of the tubular appendages of this species, and the spicule (of which there is only one form, viz. acerate, curved, cylindrical, and abruptly pointed, about 35 by 2-6000ths in.) is also much the same if not identical; so that it is possible that this may be only another but composite form of one of these appendages, hence it has been "provisionally" designated "*cohærens*." Until therefore it is known whether this is the whole of the sponge minus its base, or whether it is only part of the tubular appendages of a turnip-shaped body like that of *Desmacidon fistulosa*, the question must remain undetermined.

Loc. Port Western.

There is also another fragment of a large cylindrical tube similarly truncated (probably by the dredge), but of a *very different* kind, inasmuch as this consists of a portion of a large tube which is divided into several finger-like small ones, in which also the spiculation is so different that there can be no hesitation in at once making it the type of a new species, if not genus, in this family; hence it will be described and illustrated under the following name:—

Phlœodictyon birotuliferum, n. sp. (Pl. X. figs. 1–5.)

Fragment consisting of a stiff, hollow, cylindrical tube with thin wall, about 2½ in. in diameter and the same in length, which afterwards divides into three branches, one of which, about 2 in. long, remains single, but with a bud upon its middle (Pl. X. fig. 1, and *c*), while the other two become united about their middle, and then divide into four, which vary a little under 2½ in. from the first division; branches tubular, cylindrical, slightly diminishing towards the free ends, which are round and closed. Tubulation resilient, open, chiefly on account of the structural arrangement, of which hereafter. Colour grey. Surface smooth, especially over the main or lower portion (fig. 1, *a*) and for more than two thirds of the branches, *the rest poriferous* (fig. 1, *f*). Pores in the dermal structure covering the last third of the branches respectively. Vents not seen. Structure of the main portion of the tubulation (fig. 1, *a*) consisting of three coats, of which the external is composed of a layer of small cells in juxtaposition, about 2-6000ths in. in diameter, but being mixed with those of *Melobesia* and Polyzoa, which have overgrown this part, I am unable to say whether they are or are not all epithelial: the middle, a layer of skeletal spicules arranged parallel and close to each other, transversely to the direction of the tube; and an internal layer consisting of soft fleshy sarco-fibre, so voluminous and loose that a portion (fig. 1, *d*) hangs outside the basal end of the tube. As the main portion of the tubulation approaches the last third of the branches the sarco-fibrous or internal structure, which is of considerable thickness, gradually assumes a reticulated or clathrous character, in which the holes, which are more or less circular, infundibuliform, and fenestral in appearance, open externally in the way that will be presently mentioned. During this transition the spicules of the spiculiferous layer gradually lose their transverse arrangement and become bundled into a skeletal structure, which is fibro-reticulated longitudinally, that is the meshes are elongated in this direc-

tion; while the external layer of the smooth part becomes poriferous and supported by an additional but slighter skeletal framework, more or less composed of single spicules intercrossing each other, which support in their interstices the pore-structure; thus the smooth portion of the tubulation (fig. 1, *a*, *b*), which is imperforate for about two thirds of its course, becomes poriferous in the last third of the branches (fig. 1, *f*). Following now the structure of the latter, that is the wall of the poriferous portion, we find that it consists from without inwards of first a layer of small epithelial cells, rendered cribriform by a great number of pores (fig. 5, *b b b b*) and supported on a framework of slender intercrossing spicules (fig. 5, *c c*); second, a skeletal layer, which consists of the longitudinally fibro-reticulate spicular layer, now transformed into a quadrangular fibro-reticulate one (fig. 5, *a a a a*); and lastly the sarco-fibrous layer (fig. 4, *a*), which has assumed the structure above mentioned, in which the clathrous holes, which are infundibular (fig. 4, *b b b*), open by circular, contracted, sphinctral apertures under the pores (fig. 4, *c c c c*), so that, by placing the object between the eye and the light, the pore-structure of the surface may be seen through the infundibular spaces (fig. 4, *d d d d*), showing that whatever passes through the pores must fall directly, without the interposition of any canals, into the tubular cavity of the branch, thus affording an undoubted instance of the "mode of circulation in the Spongida" to which I have alluded in the 'Annals' of 1885, viz. that the whole of the water and its contents which enters through the pores passes directly into the interior of the sponge before the nutritive particles of it are deflected towards their destination in the spongozoa of the ampullaceous sacs or elsewhere ('Annals,' vol. xv. p. 119), for there are no excretory or any other canals here to receive it. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal spicules of two sizes, the largest, elliptically inflated at one end, followed by a straight fusiform shaft, ending in a smaller inflation of the same kind at the other end, about 55 by 1-1800th in., and the lesser one a little thinner, cylindrical, and undulating, but similarly although less inflated at the extremities (fig. 2, *a*, *b*): 2, flesh-spicule, a birotulate, consisting of a thick straight shaft, slightly swollen in the middle, terminated at each end by an umbrella-shaped head (fig. 2, *c*, and fig. 3, *a*, *b*) consisting of eight or more compressed ribs, each of which radiates from the centre of the summit backwards and outwards to a free point, while the inner or concave surface of the arched rib is united to the shaft by a thin falciform septum; total length of the birotu-

late 12-6000ths in., head 2-6000ths in. longitudinally and 3-6000ths in. transversely, shaft 2-6000ths in. thick in the centre. Skeletal spicules alone forming the middle layer of the large or lower main portion of the tubulation and that of the branches throughout, as above described; flesh-spicules chiefly in the dermal layer, rather scanty. I see one simple bihamate, about 8-6000ths in. long, in the *mounted preparation*, but cannot say for certain that it belongs to the spiculation. Size of specimen 3 in. in length.

Loc. Port Western. Depth not mentioned.

Obs. This, as the above description will show, is a remarkable sponge both in respect of general form and spiculation, irrespective of the peculiar mode of circulation. The structure of the wall of the poriferous portions is analogous to that of the tubular appendage of a Phlœodictyon, viz. *Desmacidon fistulosa* &c. Whether the specimen has been simply cut off from its base of attachment or from the body of a large sponge I am unable to say; but the difference in structure of the basal or larger portion and the quantity of fleshy fibrous sarcode hanging out of it (fig. 1, *d*) would seem to indicate that this was an extension of the body-substance of the sponge, whatever the form of the rest might be.

Halichondria scabida, Cart.

Halichondria scabida, 'Annals,' 1885, vol. xv. p. 112.

In the collection from "Port Western" there are three more specimens of this remarkable sponge, which I mention more particularly to show how a number of specimens of the same species may be necessary to describe the whole of the adult forms that it may assume.

Thus the first specimen described (*l. c.*) was "globular, compressed, and sessile," whereas the largest of the specimens from "Port Western" is branched and stipitate, $3\frac{1}{2}$ in. high by 3×2 in. horizontally; the branches thick and flabelliform, ending in subdigitate margins respectively; the largest branch about 3 in. broad by $\frac{1}{2}$ in. thick. The next in size, which has grown over the end of a large calcareous (?) *Serpula*-tube, is pyriform in shape, and presents a nodose surface whose nodes or humps are in high relief all over; while the third is so small and shapeless that it is not worth description.

All these forms may be easily derived from one another; and this kind of transition is so common in the different species of the Spongida, that it might be almost premised with certainty that at one time or another they may be found under any one of them. Hence the futility of describing the adult form of any species from a single specimen.

Halichondria pustulosa, Carter (dry).

Halichondria pustulosa, 'Annals,' 1882, vol. ix. p. 285, pl. xi. fig. 1, *a–g*.

Specimen small, massive, convex above, about ½ in. high by 1¼ in. in diameter. Colour light grey. Surface closely overscattered with discoid and pustuliform eminences composed of linear spicules extending from the circumference to the centre, which can thus, by being raised or depressed, be opened or closed as occasion may require; each presenting a poriferous area charged with the flesh-spicules of the species, or a simple oscular hole for a vent, as the case may be; in all respects the same as the Falkland-Island specimen (*op. et loc. cit.*), but with the large acuate spicule smooth instead of spined, and the "tibiella" or straighter spicule for the most part obtuse or only slightly inflated at the ends. I did not see any bihamates, but then these were very scanty in the Falkland-Island specimen.

Halichondria compressa (incertæ sedis).

Massive, erect, compressed; thick, with wide flat border; longitudinally convex, contracted towards the base or point of attachment. Consistence subcompact. Colour sponge-yellow. Surface even, covered with a cribriform dermal structure composed of small spiniferous spicules, circumscribing the pores and vents respectively, the former chiefly confined to the sides and the latter entirely to the flat border. Structure subcompact, consisting of sarcode densely charged throughout with spiniferous spicules in the midst of fibre chiefly composed of smooth ones, the whole plentifully traversed by the canals of the excretory systems. Spicules of two kinds, both acuates, but the larger smooth and the smaller remarkably spinous:—1, smooth spicule, acuate, long, curved, fusiform, subcapitate, abruptly pointed, 50 by 1-6000th in.; 2, spiniferous, acuate, curved, remarkably prickly from the size, number, and unequal length of the spines, which cover the whole of the shaft, 26 by 3-6000ths in., including the spines, which, base to base on both sides, are together equal to the transverse diameter of the shaft. No. 1 is confined to the fibre and no. 2 chiefly to the sarcode, especially on the surface, but is sometimes mixed with no. 1 *in* the fibre, and sometimes appears to be arranged in a linear form by itself; very abundant thoroughout. No flesh-spicules, that is anchorates or bihamates, while the spiniferous spicule, although chiefly confined to the sarcode, seems to be too large to be considered a flesh-spicule. Size of largest specimen

(for there are three of different sizes, but all of the same shape) 4 in. high, 5 in. long, and 1 in. thick, which is the breadth of the flat border or summit.

Loc. Port Western.

Obs. This species is chiefly characterized by the intensely prickly aspect of the spiniferous acuate, while the smooth acuate, which is confined to the fibre, very much resembles one of the forms assumed by the "tibiella" in the *Halichondriæ.* But at present, as I cannot find an undoubted skeletal acuate and there are no flesh-spicules, I can only place it among the *Halichondriæ* provisionally.

Halichondria stelliderma (incertæ sedis).

Specimen subglobular, bicornute, growing round the small stem of a *Gorgonia*, imbedding at the same time much foreign material together with the spicules of the *Gorgonia.* Consistence soft, resilient. Colour grey. Surface uniformly scattered over with small cones rising out of a general, fibro-reticulate, dermal structure, which, together with the opacity of the conical eminences, gives the stellate appearance of which the latter form the centres of the stars respectively; cones about 1-24th in. in diameter at the base, about the same height, and about twice this distance apart, surmounted by a single short filament of the internal fibro-skeletal structure. Pore-areas occupying the interstices of the dermal fibro-reticulation. Vents mostly large, sparsely scattered over the surface, one at the end of each horn-like process of the body, each provided with a strong sphinctral sarcodic diaphragm. Internal structure loose, consisting from without inwards of a thin skin followed by large subdermal cavities opening into "fold-bearing" ? excretory canals, which traverse plentifully the body-substance and end in the vents mentioned, the sarcode being supported on a reticulated spiculo-fibrous structure whose circumferential filaments terminate in the summits of the cones, also as above mentioned. Spicules (which, from their smallness and delicacy, cannot be distinctly seen until a minute fragment of the sponge has been mounted in balsam and placed under the microscope) of two kinds, viz. skeletal and flesh-spicules. Skeletal spicule very slender, smooth, almost cylindrical, slightly inflated at each end, 40 by $\frac{1}{2}$-6000th in.; flesh-spicule a very minute equianchorate, whose shaft is so curved that it looks almost equal to half a circle, and of whose three flukes the two lateral ones are spread out almost at right angles to the head; about $2\frac{1}{2}$-6000ths in. long, but so fine that it can hardly be seen

satisfactorily with a microscopic power of less than 300 diameters; while the skeletal spicule is chiefly confined to the spiculo-fibre, the flesh-spicule is very abundant everywhere, and at first so much presents the appearance of a minute bihamate, from the minuteness of the flukes and their lateral expansion, that without microscopical examination it might easily pass for one. Size of specimen $2\frac{1}{2}$ in. high by $2 \times 1\frac{1}{2}$ in. horizontally.

Loc. Port Western.

Obs. This anomalous species, characterized by the stellidermatous structure and its spiculation, especially the form of the equianchorate, I shall also provisionally place among the *Halichondriæ*, to which it appears to me to be most nearly allied. In the mounted specimen I see a *single* bihamate of the common form about $7\frac{1}{2}$-6000ths in. long, that is much larger than the anchorate, and the skeletal spicule looks very much like the "tibiella" of a *Halichondria*; but here, again, I could find no skeletal acuate, and the bihamate might not belong to the spiculation.

There is a certain amount of resemblance between this species and that which will presently be described under the name of "*Pseudohalichondria clavilobata*;" but there is no sand-fibre, although much foreign material is dispersed through the sarcode, while the dermal structure is closely analogous, each species being covered with conical eminences, through which a filament of the skeletal structure protrudes, although this of course is different in composition, being spiculiferous in one and areniferous in the other.

Histioderma verrucosum, n. sp.

Specimen flat or slightly convex, growing over agglomerated sand, presenting a great number of wart-like appendages on the surface. Colour grey when fresh. Surface even, smooth, interrupted only by the wart-like appendages, which consist of small, hollow, ficoid bodies scattered irregularly over it, each consisting of a constricted neck, which is in continuation with the histiodermal surface, and an inflated portion or head, which is composed of hollow, thin, reticulated, clathrous structure, the whole averaging about 3-12ths in. long by 1-12th in. in its greatest transverse diameter. Pores in the interstices of the reticulated structure of the head. Vents opening below, not well seen. Structure consisting of a flat basal or body-mass of sarcode and spicules covered with a compact, thick, textile, dermal layer, from which the wart-like appendages are prolonged; appendages opening into the subdermal cavities and through them again into large canals entering into the body-

substance. When dry the body-substance, which is massive and brown in colour, contrasts strongly with the dermal layer, which, becoming corrugated and more or less detached by contraction in the line of the subdermal cavities, permits the openings of the wart-like appendages to be seen from the inner side, where they open into these cavities. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal, smooth, cylindrical, straight, slightly inflated at one end and more or less obtuse or round at the other, about 100 by 1-6000th in.; 2, flesh-spicules of two forms, viz. bihamate and equianchorate, the former C-shaped, elongate, about 9-6000ths in. long, and the latter slightly "angulate" in the shaft, about 5-6000ths in. long, both belonging to the common forms. No. 1 is the skeletal spicule generally and no. 2 the flesh-spicule, which is most abundant in the clathrous structure of the wart-like appendages. Size of specimens, of which there are three, now in their dry and corrugated state, about an inch high by $1\frac{1}{2}$ in. in horizontal diameter, each bearing upwards of forty wart-like appendages.

Loc. Port Western.

Obs. At first sight this species looks very like a *Polymastia*, especially *P. robusta*, Bk. (Mon. Brit. Spong. vol. iii. pl. x. fig. 5), although not so like *P. bicolor*, Cart., of these parts ('Annals,' 1886, vol. xvii. p. 119), in which the nipple-like process, instead of being clathrous in structure (like basket-work), is uniformly covered with a close villous surface, which arises from the usual addition in *Polymastia* of a layer of minute pin-like spicules intermingling with the sharp outer ends of the large skeletal ones of the interior. In *Polymastia*, too, there are no flesh-spicules, ? excretory system as in *Polymastia*.

Our species, viz. *Histioderma verrucosum*, is more nearly allied to *H. appendiculatum*, Cart., which was found among the "Deep-sea Sponges" dredged up from the Atlantic Ocean on board H.M.S. 'Porcupine,' of which I have given an illustrated description ('Annals,' 1874, vol. xiv. p. 220, pl. xiv. figs. 23–25), and to *Halichondria phlyctenodes*, also a histiodermal sponge (*ib.* 1876, vol. xviii. p. 314, pl. xv. fig. 35).

Histioderma polymasteides, n. sp.

Very similar in all respects to *H. verrucosum*, but with the "wart-like appendages" a little larger, more pointed, lanceolate, and the spiculation different generally. Appendages pointed, leaf-like in outline, *i. e.* when compressed, about $\frac{1}{2}$ in. long and 2-8ths in. in their greatest trans-

verse diameter. Body-substance yellowish grey in colour. Spicules of two kinds, viz. skeletal and flesh-spicules :—1, skeletal, inflated at each end, or with one end more or less sharp-pointed, varying greatly in size, the thickest in the mounted preparation being about 90 by $2\frac{1}{2}$-6000ths in., and the thinner ones about 180 by $1\frac{1}{2}$-6000th in., but hardly any two alike in this respect; 2, flesh-spicule, a simple navicular-shaped anchorate of the common form, about 8-6000ths in. long. No. 1 is the skeletal spicule generally, and no. 2 the flesh-spicule, which is most abundant in the clathrous structure of the appendages. Size of specimen now dry and corrugated about $\frac{1}{2}$ in. high by 2 in. in horizontal diameter; bearing upwards of twelve appendages.

Loc. Port Western.

Obs. The same observations apply to this species as to the foregoing one, *H. verrucosum*. Without microscopical examination of their elementary parts it would be very easy to mistake both species for specimens of *Polymastia*.

Pseudohalichondria clavilobata, n. sp. (Pl. X. figs. 6–9.)

Specimen large, massive, composed of several claviform lobes of different sizes, large and small, united together into a common mass, which becomes contracted towards the base into a substipitate form, expanding again below, to produce the root-like attachment (Pl. X. fig. 6). Consistence subcompact, yielding. Colour yellowish white. Surface even, presenting a stout, soft, fibro-reticulation (fig. 9, *a a*), indistinctly covered with small epithelial cells and pore-areas (fig. 9, *b b*), in the midst of which are a great number of circular, monticular elevations, terminated respectively by a single sand-cored filament (fig. 6, *b b b b*, and fig. 9, *d*). Pores in the interstices of the fibro-reticulation (fig. 9, *b b*). Vents small, in the prominent parts of the lobes (fig. 6, *c c c c*). Structure internally subcompact, covered with a cortical layer 1-24th in. thick, composed of soft, compact, fibrillous structure, through which the pores, which are about 4-1800ths in. in diameter, have to pass before they reach the subdermal cavities; skeletal support consisting of thick sand-fibre, which, extending in more or less longitudinal lines from the base upwards, branches out towards the circumference of lobes, where it ends in the monticular elevations mentioned (fig. 9, *d*), which, from the transparency of the quartz-sand coring the filaments by which these are surmounted, presents the appearance of a punctum like a small vent; mixed with strongly developed spiculiferous

fibre in the sarcode bearing spicules proper tothe species; the whole traversed plentifully by the canals of the excretory systems, which end in the vents mentioned. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal, straight or flexuous, fine, smooth, almost cylindrical, slightly constricted at one end, so as to present the appearance of an incipient inflation, abruptly pointed or obtuse at the other, about 65 by $\frac{2}{3}$-6000th in. (fig. 7, *a*); 2, flesh-spicule, very peculiar in form, consisting of a thick, cylindrical, C-shaped shaft, about 3-6000ths in. long, spined over the convexity towards each end (fig. 7, *b*, and fig. 8, *a*, *d*); spines obtuse, erect, six or more in number, continued backwards from each end for about one third of the length of the shaft, leaving the central third smooth (fig. 8, *a*); ends, when viewed directly, presenting a triangular form simulating those of an equianchorate (fig. 8, *d*). Sand-fibre, which greatly predominates in quantity over the spiculation, and thus affords the chief skeletal support, composed of comparatively large grains of quartz and other foreign microscopic bodies forming a thick fibre about 1-90th in. in diameter, that is, about as broad as the skeletal spicule is long (fig. 9, *d*). No. 1 scattered through the body generally or surrounded by a minimum of kerasine in fibrous bundles; no. 2 also scattered through the sarcode generally, most abundant on the surface. Size of specimen about 6 in. high by 4 × 4 in. horizontally.

Loc. Port Western.

Obs. Were there nothing but the peculiarly-shaped flesh-spicule, which, viewed in front, looks like an equianchorate, and laterally like a bihamate, to distinguish the species, this would be sufficient; but with the presence of the thick sand-fibre the combination is unmistakable, especially with the monticular elevations pierced by the circumferential ends of the sand-fibres and the unusual thickness of the skin or cortical layer which the pores have to traverse, so that instead of being holes in a thin film, they consist of so many short canals in a thick one.

In general structure and colour like a *Halichondria*, while the sand-fibre is like that of a Psammonematous sponge; hence I have named it provisionally *Pseudohalichondria clavilobata*, not forgetting that it possesses a spiculation which in form hitherto has not been found in any species of *Halichondria*, or, indeed, in any other kind of sponge.

Pseudoesperia enigmatica olim *Esperia parasitica.*

In 1885 ('Annals,' vol. xv. p. 108, pl. iv. fig. 1, *a*, *h*) I

gave a description of this sponge under the idea that it was a parasitic growth of an *Esperia* over the sand-fibre of a dead Psammonematous sponge; but having received another specimen of the same kind from Mr. Wilson, which shows that this could not have been the case, for skeletal spicules of the *Esperia* are mixed with the quartz-grains of the Psammonematous fibre, I saw that the name which I had given to it was not only altogether inappropriate, but misleading, in short that it was an *Esperia* which had built up the *whole* structure; hence I propose to change the name of "*Esperia parasitica*" to "*Pseudoesperia enigmatica*," following the course which I have laid down for the location of such compound sponges, explained in the 'Annals' of 1885 (vol. xv. pp. 319–321). Thus it might be placed in the order HOLORHAPHIDOTA at the end of the group to which it more particularly belongs, viz. the "Esperina." It is a very remarkable combination, but not more so than the covering of a Psammonematous structure with Luffarid fibre, as described above under the name of *Pseudoceratina typica* (p. 287), or that in the species just mentioned, viz. *Pseudohalichondria clavilobata*, which is accompanied by a Holorhaphidotic spiculo-fibre.

Suberites spinispirulifera, Cart.

Suberites spinispirulifera, 'Annals,' 1879, vol. iii. p. 345, pl. xxviii. figs. and

Specimen consisting of a thick crust about ½ in. high and 4 in. square. Colour yellowish. Surface pitted, pits surrounded by ridges, altogether forming a subreticulated pattern. Pores not seen. Vents here and there in the pits. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal spicule, subpin-like; 2, flesh-spicule, consisting of a spiniferous shaft, spirally twisted for about one turn and a half.

Loc. Port Western.

Obs. This is a varietal form of that from Port Elizabeth (Cape Colony), the type specimen of which, described and illustrated in 1879 (*l. c.*), is in the British Museum, bearing my running nos. 13 *h* and 15 *h*, registered 71. 5. 12. 1.

Suberites (*Hymeniacidon*) *carnosus*, Bk.

Suberites (*Hymeniacidon*) *carnosus*, Bk., Mon. B. S. vol. iii. pl. xxxiv. figs. 5–9.

Specimen fig-shaped, with globular head and contracted narrow stem. Head 1 in. in diameter. Growing on the valve of a *Pecten*.

Loc. Port Western.

Trachya globosa, var. *rugosa*, n. var.

This is a spherical variety with a dark grey cortex, pitted uniformly all over the surface, the pits consisting of subcircular depressions with raised borders in juxtaposition. Stipitate, with a large, round, single vent on the summit. Spiculation the same as that of the original species described in the 'Annals' of 1886 (vol. xvii. p. 121), viz. consisting of enormously long acerates accompanied by small bihamates.

Loc. Port Western.

Obs. In this variety the bihamates, on account of their smallness, do not come out distinctly until a bit has been dried and mounted in balsam, when they make their appearance abundantly, together with the groups of dark pigment-cells which colour the cortex, thus resembling the Tethyina (*T. cranium* &c.); but there are no trifid spicules anywhere.

Trachya horrida, n. sp.

Massive, irregularly elliptical, elongate or bolster-shaped, growing round a similarly-shaped nucleus of agglomerated sandy rocks; presenting a glistening villous surface, produced by the projecting ends of the spiculation. Colour grey. Surface uniformly even and villous. Pores not seen. Vents few and not conspicuous. Internal structure very compact, consisting of sarcode densely charged with the spicules of the species. Spicules of one form only, viz. acerate, but of two sizes, the largest, long, smooth, fusiform, curved, and gradually narrowed to a sharp point at each end, about 750 by 12-6000ths in., and the other, the smallest, of the same form but variable in measurement. No. 1 chiefly constitutes the body-mass, where the spicules are arranged parallel to each other, and, radiating from the base to the circumference, become mingled there with a layer of no. 2, thus causing the specimen (in a vertical section) to present a cortical layer about 1-18th in. thick. Size of specimen about 6 in. high from the base of attachment, which was at one end, and $3\frac{1}{2} \times 2$ in. in horizontal diameter, varying in thickness with the irregularities of the piece of rock over which it has grown, being in some parts 2 in. thick.

Loc. Port Western.

Obs. Designated "*horrida*" on account of the disagreeable manner in which the large spicules are torn away by adhering to the fingers when the specimen is handled.

Eccœlonida.

Cliona celata, Grant.

Infesting the shell throughout of a large smooth bivalve, about $2\frac{3}{4}$ in. long and $2\frac{1}{4}$ in. high.

Vioa Johnstonii, Schmidt.

Vioa Johnstonii, Atlantisch. Spongienf. 1870, p. 5, Taf. vi. fig. 18.

This carmine-coloured boring sponge, which, for the most part, is concealed under the calcareous crust of a *Melobesia*, presents itself externally under the form of little heads filling circular holes of the same size among the conceptacles of the *Melobesia*, where, under a 2-inch lens, it may be easily recognized by its bright carmine colour. The holes, which are about 1-48th in. in diameter, are occupied by the pore-areas and vents respectively, as in all other sponges of the kind, the latter being, as usual, provided with a sphinctral sarcodic diaphragm. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal spicule, pin-like; 2, flesh-spicule, a spinispirula of four bends, about 10-6000ths in. long.

Loc. Port Western.

Obs. This chiefly differs from *Vioa Johnstonii* in the spiculation being smaller than that of the Adriatic species, but not sufficiently to constitute in any respect even a variety.

Stelletta ochracea, n. sp.

Specimen irregularly cylindrical, bolster-shaped. Colour bright ochre-yellow throughout. Surface even. Pores in juxtaposition over the surface generally. Vents few and scattered here and there. Structure compact, without marked cortex, but possessing a superficial layer of large epithelial cells mixed with small acerates and minute bacillar spicules. Epithelial cells 8-6000ths in. in their longest diameter, and the "granules" (cellulæ) which contain the yellow colouring-matter about $1\frac{1}{2}$-6000th in., the latter plentifully extravasated into the tissue generally, which gives the species its yellow colour. Spicules acerate, trifurcate, and bacilliform:—1, acerates of two sizes, both alike in form, one, the larger, about 240 by 6-6000ths in., constitutes the usual body-spicule, and the other, or smaller, the flesh-spicule of the surface, varying under 35 by 1-6000th in.: 2, trifurcate, consisting of three straight arms, radiating at equal angles from each other, each of which is furcated, that is divided into two

others, which are sharp-pointed, and all radiating from a common centre; diameter of the whole 63-6000ths in.: 3, flesh-spicule, bacillar, smooth, cylindrical, curved, often inflated in the centre, varying in length under 5-6000ths in. No. 1 in its large form belongs to the body-substance, and in its smaller one to the surface. No. 2 is congregated round the circumference immediately under the thin dermal layer; and no. 3 in the surface itself. Size of specimen about $1\frac{1}{2}$ in. high by $5\frac{1}{2} \times 3\frac{1}{2}$ in. horizontally.

Loc. Port Western.

Obs. The yellow colour at first sight seems to characterize this species; but the most peculiar feature is the presence ot the *trifurcates* round the circumference, evidently representing the head of the "zone-spicule" without the shaft; hence there is *no zone-spicule* of this kind *here*, as in the usual forms of *Stelletta*. I saw neither "forks" nor "anchors," while the intense yellow colour of the excretory canals, where cut across, showed how the pigmental cells may be continued throughout the structure.

Stellettinopsis lutea, n. sp.

An irregular mass growing over and enclosing fragments of agglomerated sand and shells. Colour golden yellow throughout. Surface smooth, composed of fibro-reticulated tissue, whose interstices are plentifully pierced with pores, covering subjacent structure, whose irregularities cause it to present a number of small elevations of different sizes. Pores in the interstices mentioned. Vents numerous, large, scattered over the surface generally, chiefly on the larger elevations. Internal structure fibrous, charged with the spicules of the species, largely traversed by the canals of the excretory systems. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal, a large, fusiform, curved, sharp-pointed acerate; 2, flesh-spicule, a minute stellate. No. 1 chiefly constitutes the body-mass as the skeletal spicule, among which the flesh-spicule, no. 2, is plentifully distributed, but so minute that it is not very easily seen except a fragment be mounted in balsam. Size of specimen about 5 in. high by 4×4 in. horizontally.

Loc. Port Western.

Stellettinopsis purpurea, n. sp.

An irregularly-shaped hemispherical mass, truncated by having been cut off from its place of attachment (probably by

the dredge). Consistence compact. Colour red-purple. Surface smooth, but very uneven. Pores punctate, general. Vents few, large and scattered. Structure compact, covered with a cortex about 1-48th in. thick; body-substance of the usual kind in these sponges, viz. subcompact, largely traversed by the canals of the excretory system. Spicules of two kinds, viz. skeletal and flesh-spicules:—1, skeletal, acerate of two sizes, viz. very small and very large, the former confined to the cortex and the latter to the body-substance; 2, flesh-spicule, a minute stellate about $1\frac{1}{2}$-6000th in. in diameter. Pigmental cellulæ containing the purple colouring-matter confined to the epithelial cells of the surface and the excretory canals or extravasated into the tissue generally. Size of specimen about $1\frac{1}{2}$ in. high by $1\frac{1}{2}$ in. horizontally.

Loc. Port Western.

Obs. This only appears to differ from the preceding species in presenting a red-purple colour instead of a bright golden yellow.

Tethya stipitata (dry).

Fig-shaped, stipitate, rugosely corrugated over the head, smooth over the stem, which is cylindrical and rather twisted, expanding into the head above and into a root-like mass below, which is charged with coarse sand. Consistence firm. Colour reddish purple above, becoming less so towards the stem, which is colourless. Surface rugosely corrugated over the head in lines running upwards from the smooth stem, covered with an epithelial layer of small granuliferous cells in which the granules on the exposed part (that is on the head) become more intensely coloured as the summit is approached. Pores not seen. Vents in plurality, the chief and largest single, on the summit. Structure internally pale yellow in colour, consisting of the usual bundles of long spicules radiating from the centre, held together by sarcode and traversed by cavernous excretory canals which open at the vents mentioned. Spicules of two kinds, viz. skeletal and flesh-spicules. 1. Skeletal, as usual, very long and slender, of two forms—one pointed at each end and the other provided with a trifid termination consisting of three more or less short, stout, and expanded arms; both forms variable in length according to their position. 2. Flesh-spicules also of two forms, viz. one minute, the usual C- and S-shaped bihamate, about 4-6000ths in. long, and the other much larger, whose form varies from a slight curve to a parabola, cylindrical, microspined, and obtuse at the ends, which are more or less separated according to the amount of curvature, *i. e.* 9 to 13-6000ths in. apart, with a

general thickness varying under $\frac{2}{3}$-6000th in. Skeletal spicules confined to the head and stem respectively, in which the trifid ones of the stem are much larger and stouter than the acerates of the head. I could find no anchors or forks in the spiculation of the head or stem either projecting or internally, and the trifid ends of the long spicules were only to be seen at the extremity of the root, amongst the grains of sand and shreds of sarcode which firmly held the whole together. Flesh-spicules of both forms mixed together in the head, but not in the stem, where the small one is absent. Size of specimen about 3 in. high, $1\frac{3}{4}$ in. of which is stem; head 1 in. in its largest transverse diameter.

Loc. Port Phillip Heads.

Obs. This sponge, whose root in composition at the extremity shows that it had grown in a sandy bottom, very much resembles *T. dactyloidea* ('Annals,' 1869, vol. iii. p. 15, and *ib.* 1872, vol. ix. p. 82), chiefly differing from it in the plurality of vents, the consolidation of the stem, and the presence of the large flesh-spicule, together with the corrugated surface of the head, which, not becoming smooth after much soaking, does not appear to have been occasioned by the desiccation to which the specimen had been exposed. The long consolidated stem causes this species to take a position in this respect between the sessile forms, ex. gr. *T. cranium*, and the stipitate ones, viz. *T. polyura*, Sdt., whose stem is composed of a flimsy bunch of more or less separated root-spicules. *T. euplocamus*, Sdt., had a "consolidated" stem and *T. polyura* was covered with bumps (Buckeln), extending into conical processes *below* (see 'Atlantisch.' and 'Küste v. Algier. Spongien,' 1870 and 1868, Taf. vi. fig. 8, and Taf. v. fig. 10, respectively).

List of Mr. J. Bracebridge Wilson's Sponges from the Neighbourhood of "Port Phillip Heads" and "Port Western," on the South Coast of Australia, which have been described and notified respectively in vols. xv., xvi., xvii., and xviii. of the 'Annals' for 1885–86.

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Acervochalina claviformis, p. 376.

Order V. Echinonemata.

Plumohalichondria plumosa, var. purpurea, vol. xviii. p. 376.
Axinella chalinoides, var. cribrosa, p. 377.
—— cladoflagellata, p. 377, = Axinella chalinoides, var. glutinosa, p. 359, vol. xvi.
Axinella coccinea (incertæ sedis), p. 378.
Phakellia ventilabrum, var. australiensis, p. 379.
—— papyracea, p. 379.
—— villosa, p. 379.

Order VI. Holorhaphidota.

Reniera vasiformis, vol. xviii. p. 445.
Phlœodictyon cohærens (provisional), p. 446.
—— birotuliferum, p. 447.
Halichondria scabida, *Cart.* (1885), p. 449.
—— pustulosa, *Cart.* (1882), p. 450.
—— compressa (incertæ sedis), p. 450.
—— stelliderma (incertæ sedis), p. 451.
Histioderma verrucosum, p. 452.
—— polymasteides, p. 453.
Pseudohalichondria clavilobata, p. 454.
Pseudoesperia enigmatica, p. 455.
Suberites spinispirulifera, *Cart.* (1879), p. 456.
—— (Hymeniacidon) carnosus, *Bk.*, p. 456.
Trachya globosa, var. rugosa, p. 457.
—— horrida, p. 457.
Cliona celata, *Grant*, p. 458.
Vioa Johnstonii, *Sdt.*, p. 458.
Stelletta ochracea, p. 458.
Stellettinopsis lutea, p. 459.
—— purpurea, p. 459.
Tethya stipitata, p. 460.

Order VII. Hexactinellida.

None.

Order VIII. Calcarea.

The specimens of this order which came from "Port Western" are included in the list of those from "Port Phillip Heads," as above given.

Conclusion.

Thus have I described all the principal specimens of the Spongida which have been sent to me by Mr. J. Bracebridge Wilson, M.A., F.L.S., of the Church-of-England Grammar School, Geelong, Col. Victoria, South Australia. It might have been done better and more elaborately had time and youth been on my side, but could hardly have been done more correctly; therefore, so far as it goes, it places before the reader those facts which, if he be a spongologist, will not only serve to introduce him to the sponge-fauna of the locality of which it treats, but induce him to pursue the subject still further. If I have succeeded in doing this I shall be satisfied, for my sole object, like that of the generosity of Mr. Wilson, has been to advance our knowledge of this branch of natural history to the best of my ability. When we consider that, for this purpose, these sponges were at his own cost dredged by Mr. Wilson, numbered, and at the same time placed by him in a galvanized-iron vessel containing spirit, and the vessel with its contents hermetically sealed and forwarded to my address with a catalogue of the colour of the specimens respectively in accordance with their numbers and with their depths—while we (Mr. Wilson and myself) are totally unacquainted with each other personally, and I fear now (at my age) will never be otherwise—it must be admitted that, in a scientific point of view, there never was a more praiseworthy or disinterested act.

It must not be expected that the forms presented by the specimens are the only ones that may be assumed by the various species, for among the Spongida these are almost endless; but the elementary structure is *persistent*, and it is towards this for recognition that the student should direct his attention, since in this he will not be disappointed. A single fragment may afford this information, while to say what forms a sponge may assume in its adult state may require years of observation and an unlimited number of specimens.

I began the description of these sponges with, among other things, the fact that the inhalant or pore-areas might open directly into excretory canals, and thus the nutritive particles which passed into them with the water have to be deflected afterwards to the ampullaceous sacs or elsewhere where they were required ('Annals,' 1885, vol. xv. p. 117 &c. pl. iv. fig. 5 &c.); and in *Phlœodictyon birotuliferum*, which I have described and illustrated *suprà* (p. 447, Pl. X. figs. 4 and 5), this "mode of circulation" has been established by there being no *canals* at all present, in short nothing between the pore-areas

together with their subdermal cavities and the general cavity of that part of the sponge which is provided with this inhalant structure.

Again, with reference to the sponges which afford typical illustrations of the structure of two of my orders in one, nothing can be more decisive than that of *Pseudoceratina typica* (p. 287), *Pseudohalichondria clavilobata* (p. 454), and *Pseudoesperia enigmatica* (p. 455) respectively; since wherever they may be relegated hereafter, the fact of such opposite structures existing together as parts of the same sponge is established.

The type specimens of those species which I have described have, in accordance with Mr. Wilson's request, been deposited in the British Museum. It may be added that they were dredged in the month of January, and are mostly charged with ova.

EXPLANATION OF PLATE X.

Fig. 1. *Phlœodictyon birotuliferum*, nat. size. *a*, main trunk; *b*, branches; *c*, bud; *d*, portion of internal layer hanging out of the main trunk; *e*, smooth portion; *f*, poriferous portion, represented by the puncta.

Fig. 2. The same. Skeletal spicules and flesh-spicule relatively magnified to the scale of 1-12th to 1-1800th inch. *a*, large skeletal spicule; *b*, smaller one; *c*, flesh-spicule.

Fig. 3. The same. Flesh-spicule more magnified. *a*, lateral view; *b*, end view. Scale 1-12th to 1-6000th inch.

Fig. 4. The same. Surface of internal layer of poriferous portion of branches, magnified to the scale of 1-48th to 1-1800th inch. Diagrammatic, showing:—*a*, internal, clathrous, sarco-fibrous layer; *b b b b*, infundibular depressions of the same; *c c c c*, external apertures of infundibular depressions; *d d d d*, pore-structure of the surface as seen through the infundibular depressions when the object is placed between the eye and the light.

Fig. 5. The same. Surface of external layer of poriferous portion of branch, magnified to the scale of 1-48th to 1-1800th inch. Diagrammatic, showing:—*a a a a*, middle layer or large skeletal structure; *b b b b*, external layer, including epithelium and pore-structure; *c c*, spicular framework of this layer; *d*, pores; *e e e*, circles representing external apertures of "infundibular depressions" of inner layer, which can only be seen when the object is placed between the eye and the light.

Fig. 6. *Pseudohalichondria clavilobata*, half nat. size. *a a a*, lobes; *b b b b*, monticular elevations on the surface; *c c c*, vents.

Fig. 7. The same. Spiculation relatively magnified to the scale of 1-24th to 1-6000th inch. *a*, skeletal spicule; *b*, flesh-spicule, lateral and front views.

Fig. 8. The same. Flesh-spicule more magnified. *a*, lateral view; *d*, front view.

Fig. 9. The same. External surface relatively magnified to the scale of 1-96th to 1-1800th inch. *a a*, sarco-fibro-reticulate structure of surface generally; *b b*, pore-areas occupying the interstices of the same, in which the pores are represented by the little circles; *c*, monticular elevation of surface; *d*, projection of the sand-fibre.

XLIII.—*Reply to Prof. E. Ray Lankester's "Rejoinder."* By Prof. C. Claus.

The "Rejoinder" with which Prof. Ray Lankester thinks he can get over my contradiction of the accusations brought by him against me (Ann. & Mag. Nat. Hist. September 1886, p. 179) unfortunately renders it necessary for me to furnish a reply, as that author, instead of the revocation called for by me, has answered with fresh charges. Being unable to refute the proofs which I brought forward as citations, he does not hesitate to resort to the contemptible expedient of insinuations, by a reference to some past discussions between myself and other authors, in order that, being to some extent screened by suspicions deduced from them, he may commence his retreat behind the shield of "certain discussions" *—a retreat in which, by misrepresentation and falsification of the state of the case, and by new charges, the revocation is evaded. Or is it not a misrepresentation and falsification of the points at issue, counting upon want of knowledge in the reader, that Ray Lankester (sub 1) recognizes, in the circumstance that in my 'Grundzüge' of 1880 I have enunciated the genetic relation of *Limulus* to the Arachnoidea, only my acquaintance with the "general views of Huxley" and others, although, as he must know very well, I had already, in my 'Untersuchungen über das Crustaceensystem' (1876), in agreement with Strauss-Dürckheim and Huxley, thoroughly and independently discussed the genetic relations of the Gigantostraca, including *Limulus*, to the air-breathing Arachnoidea, and

* As I cannot suppose that the reader is familiar with the nature of the "certain discussions" referred to, I may state, as a brief exposition of them, that ten years ago I was reproached by Weismann with having made and published researches upon the Daphnidæ and Polyphemidæ, although I was aware that he was also engaged upon the same subjects. The articles in question are:—Weismann's memoir "Ueber Eibildung der Daphniden" (preface), in Zeitschr. f. wiss. Zool. Bd. xxxiii.; Claus, "Berichtigung und Abwehr," *ibid.*; Weismann's "Rechtfertigung," *op. cit.* Bd. xxx.; and Claus, "Anlass und Entstehung meiner Untersuchungen auf dem Daphnidengebiete," in Sitzungsb. der k.-k. zool.-bot. Gesellsch. in Wien, Bd. xxviii.

With regard to *Seison*, Edouard van Beneden stated, four years after the publication of my paper on *Seison*, that I had not mentioned his name in it, although he had told me in conversation in a coffee-house in Trieste that he had also examined *Seison*, and regarded it as a Rotifer. The articles relating to this are as follows:—E. van Beneden, "De l'existence d'un appareil vasculaire à sang rouge dans quelques Crustacées," in Zool. Anzeiger, 1880; Claus, "Erklärung in Betreff der Prioritatsreclame des Herrn Ed. van Beneden," *ibid.*; Dr. Karl Heider, "Abwehr," *ibid.*

expressed the opinion (p. 112) that the latter had been developed out of the former? If I previously ascribed the complete ignoring of this work in Lankester's article on *Limulus* to his want of acquaintance with it, I must now, after my reference to it in my reply (July 1886, p. 56), recognize in the fact of its being again ignored a determination to suppress it, which can have no other purpose than to make it appear plausible to the reader that the above-mentioned passage in my text-book demonstrates only an acquaintance with Huxley's views, but not agreement with them. And in proof of my being of the opposite opinion it is added by a truly sophistical trick:—"The fact remains that he classified the Gigantostraca under the Crustacea, and in his description* of that group said nothing of their affinities with the Arachnida." Here, no doubt intentionally, nothing is said to remind the reader that I adopted the idea of Crustacea in the broader sense as equivalent to gill-breathing Arthropoda, and within the group placed the Gigantostraca in contrast with the Crustacea *sens. str.* with Nauplius-development, the Eucrustacea. Even now I would maintain this grouping as not in the least contradictory to the opinions recently expressed; for while the Gigantostraca and *Limulus* belong genetically to the same series as the Scorpions and Spiders, they have not therefore ceased to be branchiferous Arthropoda or *Branchiata* any more than their Arachnoid nature is proved by this relationship. In Ray Lankester's opinion, indeed, *Limulus* is an Arachnid, but not in mine; and upon this, as I have already shown, rests one of the numerous differences which separate my views and Ray Lankester's. If the English author will not or cannot understand this, I have nothing further to add, and can only appeal to the sound common sense of those who are capable of judging.

Upon all other points I may be very brief, as they are quite of secondary importance in comparison with the main question which has just been discussed. In order to lessen the value of my criticism all sorts of blunders are ascribed to me—in the first place, in connexion with Packard's criticism, which requires no refutation, the erroneous notion that Ray Lankester had wished to demonstrate twelve segments in the abdominal shield of *Limulus*, and further the opinion that he had supposed the formation of a new mouth in the Arthropoda in comparison with the Chætopoda. Upon all this I shall

* It can hardly be necessary to explain that a single statement of this relationship in the general section is sufficient, especially in a condensed compendium, and that a second reference to it in the descriptive part must have seemed superfluous.

waste no more words; but the charge which is cast upon me by the ingenious author of the hypothesis "of the change of position of the buccal aperture in the Arthropoda," of having designedly ignored his memoir "On the Primitive Cell-layers &c." of the year 1873, in order to cite as my own (in my memoir on the Daphnidæ, 1876) his discovery that the Arthropod-antennæ are appendages of the trunk, is one to which I cannot avoid offering the full tribute of my admiration, and I am only in doubt whether I should wonder more at the acuteness of its logic or at the delicacy of its sentiment. Does Ray Lankester seriously believe that by this hypothesis of his, viz. the displacement of the mouth * in the Arthropoda from the false analogy of *Amphioxus*, he can establish in the mind of the judicious reader even the shadow of a claim to the interpretation and demonstration of the second antenna of the Crustacea as a trunk-appendage? Does the "adaptational shifting of the oral aperture," by which the two anterior pairs

* I here cite the whole passage relating to the hypothesis of the displacement of the mouth, in order that I may in no respect lessen Ray Lankester's services in the eyes of the reader of my reply (see Ann. & Mag. Nat. Hist. ser. 4, vol. xi. p. 335):—"The prostomium in Triploblastica is liable to be suppressed altogether in the course of individual development, the mouth becoming terminal or other modifications arising; but where it does appear it constantly carries the chief organ of sight, whilst the auditory sac is prostomial in Turbellarians, but metastomial in Tunicates, Vertebrates, and Mollusca.

"The production of individuals of an increased complexity of organization among Triploblastica, by the linear aggregation of zooids, produced by budding in the posterior or metastomial axis of growth (tertiary aggregates of Herbert Spencer) among Annulosa, and probably (though not according to Spencer) among Vertebrata, and even some Mollusca—the process occurring at a very early period and its results being *obscured*, or even *entirely resolved*, by later 'integrating' development in the two latter cases—does not affect the prostomium, which always has an axis of *anterior* growth. When a zooid-segment of a linear tertiary aggregate develops a prostomium or axis of anterior growth, the chain necessarily breaks at that point (*Microstomum*, *Tænia*, Naididæ, Syllidæ). The segmentation of the prostomial axis in Arthropoda and some Annelids, which has an appearance of being a zooid-segmentation comparable to that of the metastomial axis, on account of the identity in the character of the appendages with those of the metastomial axis, has yet to be explained. It may be suggested that it is due to a distinct breaking up of this axis like the posterior one into zooid-segments or zoonites: there is much against this supposition (see Trans. Linn. Soc. 1869, 'On *Chætogaster* and *Æolosoma*'). Much more likely, it seems, is the explanation that the oral aperture shifts position, and that the ophthalmic segment alone in Arthropoda represents the prostomium, the antennary and antennular segments being aboriginally metastomial and only prostomial by later *adaptational shifting of the oral aperture*." And then follows, for the complete confirmation of this "adaptational shifting," the passage as to the mouth of *Amphioxus*, already cited in my previous article (July 1886, p. 62).

of trunk-appendages become the first and second pairs of antennæ, really seem to him to be "precisely the same thing" as the upward movement of the first trunk-appendages, converted into the second pair of antennæ, such as is rendered probable by the origin of the nerves upon the subœsophageal ganglion and their change of position in the higher Crustacea? And it is upon such a fantastic argument as this that Ray Lankester ventures to bring against me the calumnious charge:—"Prof. Claus further has given expression to the remarkable conception that he is justified in ignoring the work of other zoologists, and treating their results as his own, provided that he does so not more than three years after they have published those results;" and in connexion therewith he feels himself justified in adopting a magisterial tone, and finally in posing as a moralizing judge,—Ray Lankester, who himself in so many controversies has had to submit to be set right, and has just furnished so fine an example of his proficiency in the noble art of sophistical falsification!

It only remains for me, with reference to my previous article (July 1886, p. 55), to point out that Ray Lankester has not given the revocation called for in its concluding passage, and therefore has himself pronounced judgment—a judgment which is strengthened and confirmed by the method adopted in his "Rejoinder."

XLIV.—*Preliminary Report on the Monaxonida collected by H.M.S. 'Challenger.'* By Stuart O. Ridley, M.A., F.L.S., of the British Museum, and Arthur Dendy, B.Sc., Associate of the Owens College, Manchester.

[Concluded from p. 351.]

Part II.

Family 3. **Desmacidonidæ** (*continued*).

Subfamily ii. *Ectyoninæ.*

Fibre normally echinated by laterally projecting spicules.

Genus Myxilla (Schmidt).

Skeleton-spicules:—(1) main, acuate, usually spined;

(2) dermal, cylindrical. Flesh-spicules tridentate equianchorates and sometimes bihamates. Skeleton usually reticulate*.

Myxilla digitata, n. sp.

Digitate. Greyish yellow. Soft and spongy. Oscula small, scattered. Fibre very indefinite. Spicules:—(1) entirely spined acuates, size ·4 by ·014 millim.; (2) bicapitate cylindricals, with well-marked heads, size ·24 by ·006 millim.; (3) tridentate equianchorates, with strongly curved shaft, length ·044 millim.

Locality. Station 142, south of Cape of Good Hope, 150 fath.

Myxilla paucispinata, n. sp.

Massive, amorphous. Pale yellow. Rather soft, fragile. Spicules:—(1) acuates, large, stout, usually curved, rather blunt, sometimes slightly spined, size ·7 by ·03 millim.; (2) smooth bicapitate cylindricals, with small oval heads, size ·4 by ·008 millim.; (3) tridentate equianchorates, with stout, strongly-curved shafts, length ·05 millim.; (4) slender bihamates, simple and contort, up to ·056 millim. long.

Locality. Station 192, south of New Guinea, 129 fath.

Myxilla mollis, n. sp.

Massive, amorphous. Creamy yellow. Very soft and spongy. Spicules:—(1) smooth acuates or spinulates, sharp-pointed, size ·42 by ·01 millim.; (2) smooth bicapitate cylindricals, with distinct oval heads, size ·22 by ·006 millim.; (3) tridentate equianchorates, shaft slightly curved, often laterally expanded at each end, length ·04 millim.; (4) simple and contort bihamates, length up to ·063 millim.

Locality. Off south-west coast of Patagonia.

Myxilla spongiosa, n. sp.

Massive, incrusting, extremely soft and spongy. Skeleton confused. Spicules:—(1) smooth, stout acuates, gradually sharp-pointed, size ·7 by ·02 millim.; (2) bicapitate cylindricals, with well-developed oval heads, usually microspined at end, size ·4 by ·01 millim.; (3) tridentate equianchorates, with shaft laterally expanded towards each end, length ·05

* As described by Bowerbank for *Halichondria.* The fibre in this genus is not echinated by laterally-projecting spicules, except where so stated; the genus is therefore in a transitional state.

millim.; (4) bihamates, usually much contort, size ·063 by ·0045 millim.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Myxilla hastata, n. sp.

Lamellar, about $\frac{1}{4}$ inch thick. Soft and spongy. Skeleton confused. Spicules:—(1) stout, gradually sharp-pointed, smooth acuates, size ·77 by ·04 millim.; (2) smooth hastately-pointed cylindricals, size ·35 by ·01 millim.; (3) tridentate equianchorate, with stout and strongly curved shaft, length up to ·04 millim. (more commonly ·025); (4) bihamates, often much contort, size ·07 by ·004 millim.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Myxilla cribrigera, n. sp.

Digitate. Dark yellowish grey. Soft and spongy. Minutely hispid. Oscula small, scattered. Pores in definite rounded areas, diameter of areas 1·0 millim., of pores ·1 millim. Skeleton confused. Spicules:—(1) stout, smooth acuates, size ·65 by ·025 millim.; (2) bicapitate cylindricals, with oval heads, sometimes minutely spined at the end, size ·3 by ·008 millim.; (3) large tridentate equianchorates, with slightly curved shaft, laterally expanded towards each end, length ·08 millim.

Locality. Station 306 A, off south-west coast of Patagonia, 345 fath.

Myxilla fusca, n. sp.

Massive, amorphous. Rather dark brown. Texture fairly firm and elastic. Sometimes minutely hispid. Spicules:—(1) entirely spined acuates, sharp-pointed, size ·52 by ·034 millim.*; (2) bicapitate cylindricals, head faintly developed, smooth, size ·42 by ·01 millim.; (3) tridentate equianchorates, with strongly curved shaft, teeth rather widely divergent, length ·047 millim.; (4) very slender bihamates, usually much contort, length ·05 millim.

Locality. Station 150, Southern Ocean, 150 fath.

Myxilla mariana, n. sp.

Massive. Pale yellowish grey. Fairly compact, but soft. Main skeleton an ill-defined reticulation of spined acuates,

* No distinctly echinating spicules seen, but sometimes entirely spined acuates, much smaller than those described, occur.

sparsely echinated by spined acuates. Spicules:—(1) entirely spined acuates, slightly curved, gradually sharp-pointed, size ·42 by ·016 millim.; (2) as (1), but much smaller, and usually straight, size ·16 by ·012 millim. (echinating); (3) smooth bicapitate cylindricals, with small oval heads, size ·3 by ·0094 millim.; (4) tridentate equianchorates, with only slightly curved shaft, length up to ·04 millim.; (5) bihamates, length up to ·057 millim.

Localities. Off Marion Island, 50–75 fath.; off south-west coast of Patagonia (var. *massa*).

Myxilla compressa, n. sp.

Massive (?), flattened. Yellowish grey. Soft and spongy. Pores in groups. Main skeleton reticulate, with triangular meshes one spicule wide. Spicules:—(1) entirely spined, sharp-pointed acuates, size ·28 by ·0155 millim.; (2) as (1), but smaller, size ·12 by ·008 millim., echinating the fibre; (3) smooth cylindricals, somewhat hastately pointed, or with small oval heads, pointed at the ends, size ·22 by ·0063 millim.; (4) tridentate equianchorates, shaft very strongly curved, length ·044 millim.; (5) bihamates, length ·02 millim. (very rarely up to ·063 millim.).

Locality. Station 320, off the Rio de la Plata, 600 fath.

Myxilla nobilis, n. sp.

Massive or lobate, may be incrusting. Greyish yellow. Soft, spongy, rather cavernous. Pores in groups. Spicules:—(1) acuates, entirely smooth or very slightly spined at base, slightly curved, gradually sharp-pointed, size ·52 by ·03 millim.; (2) much smaller, entirely spined, straight acuates or spinulates, size ·18 by ·013 millim. (echinating); (3) bicapitate cylindricals, heads slightly expanded, very short, abruptly truncated, often slightly spined at the end, size ·33 by ·0063 millim.; (4) tridentate equianchorates, shaft stout, strongly curved, length up to ·044 millim.; (5) bihamates (?).

Localities. Station 148 A, Southern Ocean, 240–550 fath. (var. ?); Station 320, off the Rio de la Plata, 600 fath. (type); Station 311, off south-west coast of Patagonia, 245 fath. (var. *patagonica*); Station 307, south-west coast of Patagonia, 140 fath. (var. *bacillifera*).

Myxilla frondosa, n. sp.

A single broad, flattened frond, ¼ inch thick. Tough,

fibrous, elastic. Conulose, especially on the convex side, which also bears the oscula, which are small and numerous. Pores on concave surface. Fibre stout, *Axinella*-like, the spicules with their bases in the centre and their apices projecting obliquely forwards. Spicules:—(1) entirely but slightly spined acuates, gradually sharp-pointed, size ·6 by ·03 millim.; (2) smaller acuates as (1), but more strongly spined, size ·28 by ·013 millim.; (3) bicapitate cylindricals, with oval heads (sometimes not distinguishable), spined at ends, size ·25 by ·01 millim.; (4) tridentate equianchorates, shaft curved and slightly swollen in the centre, length ·027 millim.; (5) bihamates, usually much contort, size ·044 by ·004 millim.

Locality. Station 170, off Kermadec Islands, 520 fath.

Genus Clathria (Schmidt).

Horny fibre well developed, cored by acuate spicules, and echinated by smaller spined acuates. Flesh-spicules small palmate equianchorates. No special dermal crust of spicules.

Clathria Lendenfeldi, n. sp.

Subrepent, cylindrical. Light yellow. Soft, fibrous, elastic. Surface hispid. Fibre stout. Spicules:—(1) straight smooth acuates or subspinulates, gradually and sharply pointed, sometimes faintly spined at base, size ·35 by ·005 millim. (dermal); (2) stout, smooth, gradually sharp-pointed acuates, slightly curved, size ·6 by ·02 millim.; (3) short, straight, bluntly-pointed acuates (main skeleton), strongly spined all over, size ·08 by ·005 millim., echinating the skeleton-fibre in great numbers; (4) minute palmate equianchorates, ·005 millim. long.

Locality. Off Port Jackson.

Clathria elegantula, n. sp.

Sessile, composed of much-flattened, expanded, divided lobes (height and breadth each about $3\frac{1}{4}$ inches, thickness $\frac{5}{12}$ inch). Pale brownish yellow. Soft, spongy, fibrous. Surface conulose, with a thin dermal membrane stretched between the conuli over large subdermal cavities. Skeleton complicated, primary lines alone cored by smooth subspinulates. Spicules:—(1) slender straight subspinulates, size ·2 by ·003 millim.; (2) slender, sharp-pointed, entirely spined echinating acuates, size ·07 by ·0032 millim.; (3) palmate equianchorates, length ·02 millim.

Locality. Station 162, Bass Straits, 38 fath.

Clathria? inanchorata, n. sp.

Erect, slender. Surface proliferating into inosculating ridges. Dull yellowish brown. Tough and fibrous. Surface minutely hispid. Fibre stout; primary lines alone cored by smooth acuates. Spicules:—(1) smooth acuates, size variable, up to ·54 by ·024 millim.; (2) sharp-pointed, entirely spined acuates, size ·072 by ·006 millim. (echinating); (3) smooth tricurvates, size ·029 by ·0016 millim.

Locality. Station 163 A, Bass Straits, 120 fath.

Genus RHAPHIDOPHLUS (Ehlers).

Differs from *Clathria* only in the possession of a distinct dermal crust of outwardly-projecting spicules.

Rhaphidophlus filifer, n. sp.

Irregularly ramose, gnarled. Greyish yellow. Hard. Surface rugose and uneven. Dermal brushes densely packed, arranged reticulately. Spicules:—(1) straight, slender, gradually sharp-pointed acuates, base usually slightly spined, size ·2 by ·0065 millim. (dermal); (2) smooth, slightly curved, stout acuates, size ·3 by ·018 millim.; (3) straight, entirely spined acuates, size ·1 by ·01 millim. (echinating); (4) minute palmate equianchorates, ·016 millim. long; (5) long hair-like tricurvates, length ·16 millim.

Locality. Station 208, Philippine Islands, 18 fath.

Genus PLUMOHALICHONDRIA (Carter).

Skeleton arranged in plume-like columns. Spicules of the main skeleton acuate and acerate; no special dermal spicule. Equianchorate flesh-spicules.

[*Plumohalichondria mammillata*, Carter.

Locality. Station 162, Bass Straits, 38 fath.]

Genus PLOCAMIA (Schmidt).

Skeleton-spicules dumb-bell-shaped and acuate; flesh-spicules equianchorate and (usually) tricurvate.

[*Plocamia coriacea*, Bowerbank, var.

Locality. Station 75, off Azores, 450 fath.]

Genus Acarnus (Gray).

Acuate and cylindrical skeleton-spicules and an echinating grapnel-spicule. Flesh-spicules palmate equianchorates and tricurvates.

[*Acarnus ternatus*, Ridley.

Locality. Tahiti, 20 fath.]

Genus Echinoclathria (Carter).

Sponge usually made up of a honeycombed mass of anastomosing flattened trabeculæ. Skeleton reticulate, with much spongin. Skeleton-spicules smooth acuates or bicapitate cylindricals; smooth echinating acuates commonly present. Minute palmate equianchorates may or may not be present.

Echinoclathria Carteri, n. sp.

Cylindrical, ramose; each branch composed of flat, ribbon-like, anastomosing trabeculæ. Pale yellow. Tough; very minutely hispid. Spicules:—(1) smooth, sharp-pointed acuates, size ·132 by ·009 millim. (in and echinating the fibre and scattered); (2) smooth, very slender subspinulates, size ·16 by ·002 millim. (scattered); (3) palmate equianchorates, length ·015 millim.

Localities. Station 162, Bass Straits, 38 fath.; Station 163 A, South-east Australia, 120 fath.; off Port Jackson, 30–35 fath.

Echinoclathria glabra, n. sp.

Massive, honeycombed. Yellow. Firm and parchment-like, glabrous. Skeleton a reticulation of well-developed horny fibres, sparsely cored by bicapitate cylindricals and sparsely echinated by smooth subspinulates. Spicules:—(1) smooth, fusiform, subspinulate, sharply pointed, size ·11 by ·0063 millim.; (2) smooth bicapitate cylindricals, size ·22 by ·0032 millim. (in the fibre and scattered). No flesh-spicules.

Locality. Station 162, Bass Straits, 38 fath.

Genus Agelas * (Duchassaing and Michelotti).

Well-developed horny fibre, echinated by verticillately-spined acuates (cylindricals). No other spicules.

* This genus is inserted here on the supposition that it has had anchorate spicules and lost them.

[*Agelas mauritianus*, Carter.

Locality. Off Tristan d'Acunha ?]

Genus Echinodictyum * (Ridley).

Skeleton reticulate, with little spongin. Skeleton-spicules smooth acerates in the fibre, sometimes accompanied by partially-projecting slender acuates; spined cylindricals or acuates echinating the fibre. No flesh-spicules.

Echinodictyum rugosum, n. sp.

Stipitate, palmato-digitate. The short stem surmounted by a broad flattened expansion. Height $7\frac{1}{2}$ inches, breadth $5\frac{1}{4}$ inches, thickness $\frac{1}{6}$ inch. Greyish yellow; hard, very rugose, with conuli. Spicules:—(1) smooth acerates, subhastately pointed, size ·3 by ·015 millim.; (2) entirely spined acuates (subspinulate), size ·13 by ·012 millim. (echinating).

Locality. Station 190, south-west of New Guinea, 49 fath.

Echinodictyum asperum, n. sp.

Bushy, cavernous, coarsely aculeated. Height and breadth about 2 inches. Deep chocolate-brown. Coarse and fibrous. Surface glabrous where intact. Fibre stout, about ·5 millim. thick. Spicules:—(1) smooth, slightly curved, gradually sharp-pointed acerates, size ·35 by ·0063 millim.; (2) straight, tapering, bluntly-pointed, entirely spined acuates, size ·17 by ·0075 millim. (echinating).

Locality. Papeete Harbour, Tahiti, 20 fath.

Family 4. **Axinellidæ.**

Skeleton typically non-reticulate, consisting of ascending axes of fibres, from which arise subsidiary fibres radiating to the surface. Fibres typically plumose. Skeleton-spicules chiefly acuate, to which acerates and (or) cylindricals may be added. Flesh-spicules rarely present, never anchorates.

Genus Hymeniacidon (Bowerbank).

Skeleton reticulate, of ill-defined spiculo-fibre, not plumose. Skeleton-spicules acuate or subspinulate.

[*Hymeniacidon caruncula*, Bowerbank.

Locality. St. Vincent, Cape Verd Islands, shallow water.]

* This genus is inserted here on the supposition that it has had anchorate spicules and lost them.

Hymeniacidon ? subacerata, n. sp.

Massive, consisting of irregularly anastomosing trabeculæ. Pale yellow, with a waxy translucent look. Rather brittle. Surface uneven, subglabrous. Main skeleton an irregular reticulation; at the surface a thin sheet of spicules, also densely and irregularly reticulate, supporting numerous small outwardly-projecting spicules. Spicules:—(1) smooth fusiform acuates, somewhat curved, apex finely and gradually sharp-pointed, base tapering, but evenly rounded off, size 1·2 by ·031 millim.; (2) straight, gradually sharp-pointed, smooth acuates or subspinulates, size ·2 by ·0063 millim., base not constricted.

Locality. Station 208, Philippine Islands, 18 fath.

Genus Phakellia (Bowerbank).

Typically flabellate or cup-shaped. Skeleton somewhat reticulate. Spicules acuate and often acerate.

Phakellia flabellata, n. sp.

Erect, stipitate, a short stem surmounted by a broad flattened lamella, $\frac{1}{8}$ inch thick. Greyish yellow, soft. One surface ribbed and furrowed, without oscula, the other comparatively smooth, bearing numerous stellate groups of minute oscula. Skeleton of stout ascending ribs, between which a rather irregular reticulation of spicules, with meshes of smaller spicules at the surface. Spicules:—(1) smooth, slightly curved, gradually sharp-pointed acuates, size ·5 by ·03 millim.; (2) smooth, straight acuates or subspinulates, rather abruptly sharp-pointed, size ·22 by ·0063 millim.

Locality. Port Jackson, 30–35 fath.

Phakellia papyracea, n. sp.

Very thin, lamelliform (? cup-shaped), minutely punctate on both surfaces; thickness $\frac{1}{12}$ inch. Yellow or brown; fragile. Very minutely hispid. Skeleton reticulate, rather rugose. Spicules:—(1) smooth, sharp-pointed acuates, size ·7 by ·02 millim.; (2) smooth, sharp-pointed acuates or subspinulates, size variable (*e. g.* ·35 by ·0063 millim.).

Localities. Station 145 A and Station 148, Southern Ocean, 310 and 210 fath.

Genus Ciocalypta (Bowerbank).

Skeleton of very definite columns of spiculo-fibre radia-

ting from a fibrous or reticulate axis, spreading out at their tops and supporting the dermal membrane with its reticulation of spiculo-fibre. Very large subdermal cavities. Spicules acuate (and sometimes acerate).

Ciocalypta hyaloderma, n. sp.

Cylindrical, ramose. Dirty brown; very delicate and fragile. Dermis stellately marked, transparent. Skeleton of axial portion both fibrous and reticulate. Spicules smooth, slightly curved, fairly gradually, but not very sharply pointed acuates; size in the dermal reticulation ·53 by ·014 millim., in the central portion 1·0 by ·037 millim.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Ciocalypta amorphosa, n. sp.

Massive, amorphous. Grey. Very spongy, fibrous, honeycombed. Dermal membrane stretched on top of numerous projecting fibrous tufts. Main skeleton confused. Spicules:—(1) smooth, slightly curved, fusiform, sharp-pointed acerates, size up to 1·7 by ·02 millim.; (2) slightly curved smooth acuates, size up to about 1·47 by ·028 millim.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Genus ACANTHELLA (Schmidt).

Ramose or bushy. Texture cartilaginous. With glabrous surface beset with ridges and spines. Skeleton-spicules smooth (acuate, cylindrical, and acerate).

Acanthella pulcherrima, n. sp.

[=*Acanthella*, sp., Ridley, Zool. Coll. H.M.S. 'Alert,' Brit. Mus. 1884, p. 463, *q. v.* for description *.]

Locality. Torres Straits, 3–11 fath.

Genus AXINELLA (Schmidt).

Typically ramose (may be massive). Fibre plumose. Skeleton-spicules acuate and sometimes acerate or cylindrical.

Axinella arborescens, n. sp.

Erect, ramose, cylindrical or flattened. Height 8½ inches, diameter of branches ⅓ inch. Greyish yellow. Texture firm

* We must add that an unequal-ended acerate is also common, though not originally mentioned, measuring about the same as the acuate.

but rather woolly. Central skeleton-axis ill-defined, giving off radiating fibres terminating in dense brushes of spicules. Skeleton-spicules smooth, slightly curved, rather abruptly pointed acuates; size ·28 by ·024 millim.

Locality. Port Jackson, 30–35 fath.

Axinella balfourensis, n. sp.

Erect, stipitate, with spreading, branched root and long, cylindrical stem, surmounted by a large head of dichotomizing finger-like, tapering branches. Height 14 inches. Yellowish grey. Stem firm and compact, branches extremely soft and spongy. Very slightly hispid. Skeleton loose, poorly developed. Spicules smooth, straight or slightly curved acuates, gradually sharp-pointed, size ·42 by ·0075 millim., of the same shape in both the dermal tufts and the main skeleton, but in the former of about half the size.

Locality. Kerguelen Island, 20–60 fath.

Axinella mariana, n. sp.

Erect, delicately branched; branches slender, somewhat flattened. Height about 2 inches. Greyish yellow. Hirsute. Texture soft and friable externally, internally tough. Skeleton, a central axis of irregularly-packed, short, bent acuates, amongst which are imbedded the bases of very large stout acuates, whose apices project far beyond the surface. Spicules:—(1) smooth (rarely slightly spined) acuates or subspinulates, sharply bent near the base, finely pointed, size variable (*e. g.* ·3 by ·013 millim.); (2) smooth acuates, usually slightly bent towards the base, finely pointed, size 2·2 by ·03 millim.

Locality. Off Marion Island, 50–75 fath.

Axinella profunda, n. sp.

Small, stipitate, branching dichotomously in one plane, slightly flattened. Height about 2 inches. Yellowish grey. Texture: axis tough and woody, with a soft spongy coat. Surface hispid. Skeleton, a central axis of longitudinally disposed large acuates, from which similar spicules radiate in tracts or brushes, surrounded by bunches of smaller slender acuates. Spicules acuate, straight, sharp-pointed, size from ·55 by ·0084 to 2·0 to ·037 millim., the bases, with few exceptions, very minutely spined.

Localities. Station 241, North Pacific, 2300 fath.; Station 281, South Pacific, 2385 fath.

Axinella fibrosa, n. sp.

Massive, lobate. Height 6½ inches. Greyish yellow. Soft, spongy, coarsely fibrous. Surface subglabrous but conulose. Skeleton of stout branching fibres, coming to the surface in tufts. Fibre consisting of a plumose core of acuate spicules almost entirely sheathed in spongin, diameter about ·4 millim. Spicules smooth acuates, slightly bent towards the base, usually very gradually sharp-pointed, size ·63 by ·015 millim.

Locality. Station 313, east of Straits of Magellan, 55 fath.

Axinella reticulata, n. sp.

Massive, sessile, with short, thick-walled, oscular tubes above. Height 1½ inch. Pale yellow. Very firm. Surface conulose, but glabrous. Skeleton an irregular reticulation, with loose plumose fibres. Spicules:—(1) smooth, slightly curved acuates, sharp-pointed, size ·45 by ·02 millim.; (2) smooth, curved acerates, sharp-pointed, of same size, scarce.

Locality. Bahia, 7–20 fath.

Axinella monticularis, n. sp.

Massive, sessile, apparently free; diameter about 1½ inch. Yellowish grey. Firm and compact, containing much foreign matter. Surface abundantly conulose. Skeleton composed of stout plumose columns ending in the surface-conuli. Spicules:—(1) smooth, gradually sharp-pointed acuates, size ·6 by ·0126 millim.; (2) entirely spined, usually subspinulate, gradually sharp-pointed, size about ·12 by ·0066 millim.

Locality. St. Vincent, Cape Verd Islands, shallow water.

Axinella? lunæcharta, n. sp.

Massive, sessile. Diameter about 1½ inch. Pale yellow. Fairly firm, but rather spongy. Surface glabrous, with numerous small monticular eminences, and fewer but much larger projections, each with a crateriform depression at the top, in which are the minute oscula. Skeleton loosely reticulate. Spicules:—(1) smooth acuates, gradually sharp-pointed, size ·4 by ·014 millim.; (2) smooth acerates, usually gradually sharp-pointed, commonly with unequal ends, size ·35 by ·0126 millim.

Locality. St. Vincent, Cape Verd Islands, shallow water.

Axinella? tubulosa, n. sp.

Erect, tubular; tubes open widely above or closed finger-like. Height 2 inches. Greyish yellow. Fairly firm. Skeleton very confused, no distinct fibre. Spicules smooth acuates:—(1) stout, fusiform, more or less bent, fairly gradually sharp-pointed, size ·87 by ·03 millim.; (2) similar, but much smaller, size ·45 by ·009 millim.; the latter especially in loose brushes near the surface.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Axinella? paradoxa, n. sp.

Sessile. Massively lobate. Diameter 1 inch. Greyish yellow. Texture indiarubber-like, internally fibrous. Surface glabrous, but conulose. Oscules grouped on tops of lobes. Skeleton of large smooth acerates, size ·87 by ·022 millim., forming very stout but very loose *Axinella*-like fibre.

Locality. Inaccessible Island, South Atlantic, 90 fath.

Genus Raspailia (Nardo).

Long, slender. A central axis of spiculo-fibre, containing much spongin, always present, from which loose tufts of spicules radiate to the surface. Skeleton-spicules chiefly acuate or subspinulate; spined echinating acuates sometimes present.

Raspailia tenuis, n. sp.

A very long, slender, flexible stem, giving off branches of the same nature as itself, and produced into a long unbranched terminal portion; no secondary branches. Diameter $\frac{1}{12}$ to $\frac{1}{10}$ inch. Greyish yellow; tough, stringy, externally friable. Surface minutely conulose, hispid. Spicules:—(1) smooth, slender acuates, almost straight, size up to 1·75 by ·018 millim.; (2) smooth slender cylindricals, size up to ·77 by ·01 millim.; (3) very slender smooth acuates, surrounding the large ones, size ·42 by ·0035 millim.; (4) small spined acuates, rather rare, imbedded in the axis, size ·175 by ·0125 millim.

Locality. Off Bahia, shallow water.

Raspailia flagelliformis, n. sp.

Stipitate, branched; stem short, rigid; branches long, whip-like. Diameter $\frac{1}{6}$ inch. Yellowish. Axis very dense. Rind thick, friable. Spicules of one form only, almost or

quite straight, smooth, gradually sharp-pointed acuates; size in surface-tufts ·3 by ·0032 millim., in deeper parts ·45 by ·009 millim.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fath.

Raspailia? rigida, n. sp.

Erect, straight (single specimen with one incipient branch). Maximum diameter $\frac{1}{6}$ inch. Yellowish grey. Tough, subrigid. Hispid. Skeleton a dense central axis of closely-packed spicules, from which rather sparse bands radiate to the surface, ending in great divergent brushes. Little or no spongin. Spicules, straight smooth spinulates or subspinulates, finely pointed; size variable, up to 2·0 by ·025 millim., usually smaller, especially in the dermal brushes.

Locality. Station 142, Agulhas Bank, Cape of Good Hope, 150 fath.

Genus DENDROPSIS *, n. g.

Skeleton-arrangement *Raspailia*-like. Skeleton-spicules acuate of various forms. Flesh-spicules minute spined acerates.

Dendropsis bidentifera, n. sp.

Erect, stipitate, dichotomously branched, branches flattened; all approximately in one plane. Greyish yellow. Tough, hard; minutely conulose and hispid. Skeleton an axial core of close-packed spicules, from which much larger spicules radiate to the surface in loose bundles surrounded by dense sheaves of the "bidentate" acuates. Spicules:—(1) smooth, gradually sharp-pointed acuates, fusiform, bent near the base, size in axis ·35 by ·025 millim., in radiating tufts 1·1 by ·044 millim.; (2) slender, smooth acuates, size up to 1·75 by ·019 millim., sometimes cylindrical; (3) slender, straight, hastately-pointed acuates, each with two sharp spikes projecting from the base, size ·56 by ·0075 millim.; (4) small spined acerates, bent, size ·09 by ·0045 millim.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fath.

Genus THRINACOPHORA (Ridley).

Long, cylindrical, axiate. Skeleton-spicules acuate and (or) acerate. Flesh-spicules trichites.

Thrinacophora cervicornis, n. sp.

Erect, dichotomously branched, like a stag's antler. Greyish

* δένδρον, tree, from the arborescent form of *D. bidentifera*.

yellow. Firm, tough, flexible, elastic. Surface minutely conulose and strongly hispid. Axis a dense reticulation of acerate spicules imbedded in spongin. Spicules:—(1) acerates, abruptly sharp-pointed, size ·28 by ·018 millim.; (2) long smooth acuates projecting from surface, size 5·2 by ·037 millim.; (3) smooth slender acuates in whorls around the last named, size ·52 by ·0075 millim.; in the rind long slender spicules, acerate to cylindrical, of about the same size; (4) trichite-bundles ·0126 millim. long.

Locality. Station 208, Philippine Islands, 18 fath.

Thrinacophora funiformis, n. sp.

Cylindrical, elongated, may be branched; flexible, rope-like. Dirty yellow. Surface beset with prominent conuli. Skeleton a dense axis of spiculo-fibre from which fibres radiate to the surface. Spicules:—(1) slender acuates, finely pointed, size up to 1·8 by ·025 millim.; (2) slender acerates with unequal ends, size up to 1·7 by ·023 millim.; (3) fusiform acerates with equal ends, bent at centre, size up to ·6 by ·023 millim.; (4) crooked acuates with apex branched into irregular short fangs, size ·52 by ·0063 millim., often in bundles; (5) trichite-bundles, size ·1 by ·01 millim.

Locality. Off Bahia, shallow water.

Suborder II. CLAVULINA (Vosmaer).

Typically corticate, skeleton typically radiate; skeleton-spicules almost always spinulate. Flesh-spicules may be present, but never anchorates.

Family 1. **Suberitidæ.**

Without flesh-spicules.

Genus SUBERITES (Nardo).

Skeleton-spicules spinulate or subspinulate, with smaller spicules of the same form radiately arranged at the surface. Surface without mammiform projections.

Suberites caminatus, n. sp.

Sessile, hemispherical; diameter about $\frac{3}{4}$ inch; with one or more usually chimney-like oscula at the summit; often forming colonies by lateral budding. Cortex dense, well defined, and packed with outwardly projecting spicules. Main skeleton of separate radiating fibres. Spicules smooth, spinulate,

size in cortex ·35 by ·01 millim., heads roundedly triangular; in main skeleton 1·2 by ·017 millim., heads pointedly oval.

Localities. Off Marion Island, 50–75 fath.; Station 320, off the Rio de la Plata, 600 fath.; Station 150, Southern Ocean, 150 fath. (a slight variety with very minute, non-tubular oscula).

Suberites senilis, n. sp.

Sessile, hemispherical; covered with very long, delicate, projecting spicules. Diameter, excluding spicules, $\frac{1}{3}$ inch. Skeleton composed of great divergent brushes of spinulate spicules arising from various levels in the sponge, with shorter spicules scattered between. Spicules spinulate:—(1) slender with oval heads, length up to 3·0 millim., diameter ·019 millim.; (2) shorter, stouter, more fusiform, with constricted neck and subglobular head, size about ·5 by ·015 millim. (intermediate forms occur).

Locality. Station 246, North Pacific, 2050 fath.

Suberites perfectus, n. sp.

Erect, lobose, but unbranched. Size $3\frac{1}{4}$ by $\frac{3}{4}$ inch. Brownish yellow. Hard, firm, very minutely hispid. Dermal membrane fairly distinct, but reduced to a network by numerous pores. Oscula small, scattered, each on a small papilla. Skeleton of radiating fascicles of large spinulate spicules, with smaller ones in close-placed brushes at the surface. Spicules spinulate, slightly fusiform, with well-marked subglobular heads, sharply and rather abruptly pointed. Size in dermal crust ·28 by ·0126 millim., in main skeleton 1·0 by ·025 millim. (but very variable).

Locality. Port Jackson, 30–35 fath.

Suberites axiatus, n. sp.

Irregularly lobose or digitate. Soft and spongy, with a thick dense axis; hispid. Skeleton, a thick central axis of longitudinally and closely-placed spicules, from which bands of spiculo-fibre radiate to the surface, where they diverge. Spicules spinulate, fusiform, with subglobular heads; size variable, in the deeper parts 1·75 by ·03 millim., towards the surface ·7 by ·0126 millim.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Suberites durissimus, n. sp.

Pedunculate, rounded, lobate. Light yellow. Hard, woody,

solid throughout. Surface even, but covered with a velvet-like pile. Skeleton very dense, consisting of closely-packed fascicles of chiefly acuate spicules radiating to the surface, and a dense dermal crust of projecting spinulates. Spicules:—(1) spinulate, with well-marked globular heads and fusiform shafts, size ·24 by ·0063 millim. (but variable), chiefly dermal, passing into (2) straight, smooth, fusiform acuates and subspinulates, size 1·5 by ·0157 millim.

Locality. Off south-west coast of Australia.

Suberites mollis, n. sp.

Stipitate, with expanded lobose head. Height 1¾ inch. Pale yellow. Stem firm but brittle; head very spongy and soft; minutely hispid. Skeleton: in the stem a dense axis of longitudinally placed spicules; in the head very diffuse, consisting of loose bands of spiculo-fibre radiating upwards and ending in brushes of smaller spicules. Spicules smooth spinulates, with fairly well-marked subglobular heads, size very variable, length up to 2·0 millim., diameter up to ·03 millim.; in the surface-brushes about ·45 by ·01 millim.

Locality. Station 148, Southern Ocean, 240–550 fath.

Suberites elongata, n. sp.

A slender fleshy stalk, expanding into attaching rootlets below, and an oval, elongated, narrow head above. Relation in length between head and stalk very variable—diameter of stalk $\frac{1}{24}$ inch, of head $\frac{1}{6}$ inch; total height about 2 inches. Pale yellow. Firm, cork-like, minutely hispid. Skeleton, a central axis of acuate spicules from which, in the head, bands of spiculo-fibre radiate outwards and upwards, branching towards the surface; also a dense dermal crust of small projecting spinulates. Spicules:—(1) straight, smooth acuates or subspinulates, size 1·8 by ·016 millim.; (2) straight spinulates, with well-marked subglobular heads, size variable, ·35 by ·0063 millim. &c.

Locality. Station 75, off Azores, 450 fath.

Suberites spiralis, n. sp.

Stipitate, cylindrical. Height 3½ inches, diameter of body ¼ inch. Stalk and axis of body very dense, body rather open and compressible. Minutely hispid. Skeleton, a dense axis of spicules from which, in the body, radiate loose fibres to the surface, arranged in a somewhat spiral manner and ending in loose brushes of smaller spicules. Spicules:—(1) straight, slender spinulates with subglobular heads, size 1·0

by ·013 millim., in the fibres; (2) similar, but much smaller, length about ·4 millim., in the surface-brushes.

Locality. Off the S.W. coast of Patagonia.

Suberites ramulosa, n. sp.

Stipitate. Stem long, slender, simple or branched, ending below in spreading rootlets, and each branch expanding above into a pear-shaped head. Texture rather soft and spongy. Surface hispid. Oscula, one at the summit of each head. Skeleton, a dense spicular axis in the stem, and in the head longitudinal tracts of similar spicu les with loose brushes of smaller ones at the surface. Spicules:—(1) straight, stout, fusiform spinulates, usually blunt, and with well-marked subglobular heads, size 1·8 by ·063 millim.; (2) slenderer, usually sharp-pointed spinulates, size 1·0 by ·028 millim., but variable, in the surface-brushes.

Localities. Station 207, Philippine Islands, 700 fath.; Station 209, Philippine Islands, 95 fath. (var. *cylindrifera*, with large blunted acuates in place of the large spinulates).

Genus POLYMASTIA (Bowerbank).

Massive, sessile, corticate; differing from *Suberites* in the presence of mammiform processes on the upper surface. Skeleton-spicules spinulate or acuate. No long supporting fringe of spicula as in *Trichostemma*.

Polymastia corticata, n. sp.

Cushion-shaped; cortex $2\frac{1}{2}$ millim. thick. Milky white. Very minutely hispid. Mammiform processes of two kinds:—(1) very numerous, hollow, flattened, closed, height $\frac{1}{3}$ inch, breadth $\frac{1}{8}$ inch; (2) a very few flattened conical tubes, sometimes fairly widely open at summit, height 1 inch, breadth at base $\frac{1}{2}$ inch; these are the oscular tubes. Skeleton:—(*a*) Of body: (1) on the outside a dense layer of brushes of small spinulates, ·28 millim. thick; (2) below this a much thicker layer of vertically set large acuates or subspinulates; below this "cortical" layer the skeleton is confused, with loose fibres. (*b*) Of the mammiform processes, outermost cortical layer as before, then stout longitudinal fibres of large spicules and a loose network of the same. Spicules:—(1) sharp, fusiform spinulates with oval heads, size ·28 by ·008 millim.; (2) fusiform acuates or subspinulates, sharp-pointed, size ·98 by ·022 millim.

Locality. Station 125, between Pernambuco and Bahia, 1200 fath.

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Polymastia agglutinans, n. sp.

Sessile, subglobular, incrusting and enveloping pebbles &c., and cementing on to its own surface numerous small foreign objects. Giving off long, stiff, slender, cylindrical, hollow processes closed at the top, free from foreign objects. Diameter of body about $\frac{3}{4}$ inch, length of fistulæ up to $\frac{1}{2}$ inch. Skeleton:—(*a*) Of body: a dermal layer of dense brushes of small spicules only present between the foreign bodies, which replace it; beneath this scattered spicules and stout columns of spiculo-fibre running to the surface. (*b*) Of processes: outside is a dense crust of small projecting spinulates, then a reticulation of larger spicules parallel with the surface, backed by a circle of stout longitudinal bands of spiculo-fibre. Spicules:—(1) straight acuates or subspinulates, subfusiform, size up to 1·17 by ·0157 millim.; (2) very small slender spinulates, size ·175 by ·004 millim. (chiefly dermal).

Locality. Station 75, off the Azores, 450 fath.

Genus PROTELEIA * (Dendy & Ridley).

Differs from *Polymastia* in the presence of a grapnel-like spicule projecting from the surface of the body.

[*Proteleia Sollasi*, Dendy & Ridley.

Locality. Simon's Bay, Cape of Good Hope, 10–20 fath.]

Genus TRICHOSTEMMA (M. Sars).

Corticate, free-living, discoidal or hemispherical, with a marginal fringe of long supporting spicula. Skeleton-spicules mainly spinulate.

Trichostemma Sarsii, n. sp.

Discoidal; flattened, especially on the upper surface. Diameter of largest specimen $\frac{1}{2}$ inch, thickness $\frac{1}{8}$ inch. One osculum (or more?) on the summit of oscular tube (or tubes?) on the flat surface. Skeleton: a dense thatch of spicules covers the lower convex surface, radiating outwards and upwards; the upper surface is provided with a thick cortex of projecting spicules, beneath this lies a confused mass of spicules. Spicules:—(1) straight, slender spinulates or subspinulates, forming the thatch and fringe, length up to 4·7 millim., diameter ·02 millim.; (2) short, stout, fusiform spinulates, in the interior

* For full description and discussion of genus and species *vide* Ann. & Mag. Nat. Hist. ser. 5, vol. xviii. p. 152, pl. v.

of the sponge, with globular heads, size ·3 by ·016 millim. Spicules of cortex spinulate or subspinulate, intermediate in size.

Localities. Station 73, off the Azores, 1000 fath.; Station 184, S.E. off Cape York, Australia, 1400 fath.

Trichostemma irregularis, n. sp.

Resembling *T. Sarsii* in general shape, but less regular, thicker, and with strongly hispid upper surface. Diameter $\frac{2}{3}$ inch, thickness $\frac{1}{3}$ inch. Skeleton arranged as in *T. Sarsii.* Spicules, all spinulate or subspinulate, of very variable length, those of cortex and interior much longer and slenderer than in *T. Sarsii*, the former often projecting 1 millim beyond the surface; size of the latter about ·5 by ·012 millim., often longer.

Locality. Station 299, west of Valparaiso, 2160 fath.

Genus TENTORIUM * (Vosmaer).

Sessile, columnar or conical, with a dense cylindrical sheath of large, external, longitudinally arranged spicules. On the top a proper cortex containing bundles of smaller spicules with large subdermal cavities between them. Pores on upper surface only. Oscula tubular, in centre of upper surface.

[*Tentorium semisuberites* (Schmidt).

Localities. Stations 49 and 50: S. of Nova Scotia, 85 and 1250 fath.; Inaccessible Island, South Atlantic, 60–90 fath.]

Genus STYLOCORDYLA (Wyville Thomson).

Corticate. With distinct head and stalk. Skeleton in head radiate, with cortical layer of smaller spicules. Skeleton-spicules acerate.

[*Stylocordyla stipitata* (Carter).

Localities. Station 49, South of Nova Scotia, 85 fath.; Station 147, Southern Ocean, 1600 fath.; off Bahia 7–20 fath. (Station 145, Southern Ocean, and off Kerguelen, 10–100 fath.: var. *globosa*, n.; characterized by globular bullet-like head.)]

Genus QUASILLINA (Norman).

Sponge corticate, stipitate, with oval body †, bearing a single

* = *Thecophora*, Schmidt.

† The soft internal tissues generally shrink up and disappear, and thus give to the sponge a characteristically hollow form.

osculum at the summit, and a short stalk. In the cortex primary skeleton-fibres ascend in parallel lines from the base, crossed at right angles by secondary ones. Skeleton-spicules large and small acuates.

[*Quasillina brevis* (Bowerbank).

Locality. Station 49, south of Nova Scotia, 85 fath.]

Genus Cliona (Grant).

Sponge of boring habit. Skeleton-spicules spinulate.

Cliona dissimilis, n. sp.

Incrusting and boring into a flat porous Madreporarian coral. A thin cortex incrusts the entire corallum on both surfaces, varied by abundant, small, round, cushion-like thickenings, each of which blocks up the entrance to an excavated canal. On one surface these cushions are more abundant than on the other, and present no opening to the naked eye; they are, however, perforated by minute inhalant canals. On the other surface each is perforated by a small osculum. Skeleton chiefly developed in the thin cortical layer, where it consists of spinulate spicules usually more or less vertically placed. Spicules rather slender spinulates with very well-marked "enormi"-spinulate heads; size about ·32 by ·0065 millim.

Locality. Station 188, south of New Guinea, 28 fath.

Family 2. **Spirastrellidæ.**

With special flesh-spicules, which chiefly form a dermal crust.

Genus Spirastrella (Schmidt).

Massive, sessile, with spinulate or acuate skeleton-spicules and spinispirular flesh-spicules*.

Spirastrella massa †, n. sp.

Massive, large. Pale yellow. Of somewhat cheese-like texture, rather spongy. Dermal membrane thin. Pores very abundant in some parts. Skeleton very diffuse, with no

* For figure *vide* Carter, Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pl. xxix. figs. 11, 12, which represent two forms of spinispirular spicules.

† Represented by two large squarish blocks, evidently cut from one or two large specimens.

distinct spiculo-fibre; most compact just below the surface, forming a cortical layer. Also with irregular tufts of projecting spicules at the surface. Spicules:—(1) smooth acuates, rather irregular in form, size ·45 by ·0065 millim.; (2) spinispirulæ, the largest slender, with five or six bends, length ·044 millim.; more abundant are smaller ones, often with only one joint, ·0095 millim. long.

Locality. Station 162, Bass Straits, 38 fath.

Spirastrella solida, n. sp.

Sessile, lobate: $3\frac{1}{2}$ inches high by $2\frac{1}{3}$ inches at base. Light yellow. Very firm and hard, with much foreign matter at base. Surface uneven, subglabrous in appearance. Dermal membrane rather dense, heavily laden with spinispirulæ. Oscula at tops of lobes. Pores scattered. Skeleton a dense but irregular reticulation of spinulate spicules; no fibre; with loose radiating brushes of smaller spinulates at the surface. Spicules:—(1) spinulates, with well-developed subglobular heads, size in main skeleton ·7 by ·019 millim., in dermal brushes ·31 by ·0094 millim.; (2) spinispirulæ, (*a*) minute, slender, with about three bends, size ·0126 by ·0025 millim., (*b*) a few much larger and relatively slenderer, size ·056 by ·0025 millim.

Locality. Station 208, Philippine Islands, 18 fath.

Spirastrella papillosa, n. sp.

Erect, sessile, conically lobose. Oscula at apex. Surface covered with abundant low papillæ. Height 6 inches. Grey. Texture fairly firm, rather spongy. Dermal membrane thin, loaded with spinispirulæ, arranged so as to leave small pore-bearing areas. Skeleton diffuse, fibres very slightly developed, especially dense just below surface; at the surface also are irregular brushes of small spinulates. Spicules:—(1) spinulates, with broadly oval heads, size ·5 by ·0157 millim.; (2) similar, but smaller (dermal), size ·3 by ·008 millim.; (3) spinispirulæ, stout, with three or four bends and strong spines, size (excluding spines) ·05 by ·009 millim.; smaller ones (young forms?) also occur.

Locality. Port Jackson, 30–35 fath.

Genus Latrunculia (Bocage).

Massive, sessile, with acuate (or acerate?) skeleton-spicules and "sceptrella"* flesh-spicules forming typically a dense

* For figure *vide* Carter, Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pl. xxix. fig. 14, which represents one modification of the "sceptrella."

dermal crust. Typically corticate; beset with mammiform projections, some of which bear oscula and others pores.

Latrunculia apicalis, n. sp.

Sponge hemispherical. Osculum-bearing and pore-bearing processes distinct: the former at the top of the sponge, in form conical; the latter smaller, more abundant, abruptly truncated. Yellowish grey. Corticate. Fairly compact, but spongy internally. Skeleton: the sceptrellæ form a continuous dermal crust, below which the skeleton is loose and irregular, denser towards the surface. Spicules:—(1) smooth acuates, size ·6 by ·014 millim.; (2) sceptrellæ, with expanded spinose base, straight shaft, and four or five discoid whorls with indented margins, the lowest whorl the largest; shaft produced upwards into a long, smooth, terminal portion; length of spicule ·126 millim., diameter of largest whorl ·044 millim.

Localities. Off Christmas Harbour, Kerguelen, 70 fath.; Station 320, off the Rio de la Plata, 600 fath.

Latrunculia brevis, n. sp.

Much resembling in appearance and skeleton-arrangement *L. apicalis*, but the corticate skeleton of acuates is barely represented. Spicules:—(1) smooth acuates, size ·6 by ·0126 millim.; (2) sceptrellæ, differing from those of *L. apicalis* in having no apical prolongation. The upper whorls are approximated so as to form a thick bush at the top; length ·05 millim., diameter of largest whorl ·044 millim.

Locality. Station 320, off the Rio de la Plata, 600 fath.

Latrunculia Bocagei, n. sp.

Subglobular, sessile; resembling *L. apicalis* in appearance and skeleton-arrangement. Corticate. Spicules:—(1) smooth acuates, size ·6 by ·018 millim.; (2) sceptrellæ, with slightly expanded base, armed with two whorls of spines, and a smooth, stout shaft, bearing three distinct, subequal, separate whorls towards the apex, and ending in a tuft of spines which follows close upon the last whorl. Each disk-like whorl is deeply but unequally notched all round; length ·07 millim., diameter of whorls ·03 millim.

Locality. Kerguelen, 10–70 fath.

Latrunculia (?) *acerata*, n. sp.

Massive, cake-like; without mammiform projections.

Pores scattered through a distinct dermal membrane. Skeleton :—(*a*) dermal, an irregular feltwork of slender cylindrical spicules; (*b*) main, a reticulation of large acerate spicules, with fibres distinct in parts. Spicules :—(1) smooth, slightly curved cylindricals, size ·48 by ·012 millim., chiefly dermal; (2) long, smooth, curved acerates, sometimes sharp and sometimes blunt, size ·9 by ·025 millim.; (3) a very small and slender sceptrella-like spicule, consisting of a slender shaft, bearing two saucer-like whorls near the base, with very slightly denticulated margins, length ·037 millim., diameter of larger (upper) whorl ·0125 millim. Occurring scattered, chiefly in the dermal membrane.

Locality. Station 135 ?, 60 fath.

ERRATUM.—We find that the generic name *Trochoderma* (p. 344, *suprà*) has been already used; we therefore propose instead the name *Axoniderma*, from Greek ἄξων, a wheel (type species *Axoniderma mirabile*, Ridley and Dendy).

XLV.—*On* Harpacanthus, *a new Genus of Carboniferous Selachian Spines.* By Dr. R. H. TRAQUAIR, F.R.S., F.G.S.

UNDER the name of *Tristychius fimbriatus* a small but interesting Selachian spine from the Carboniferous Limestone of Gilmerton, near Edinburgh, was described and figured by Mr. T. Stock in a paper "On the Structure and Affinities of the Genus *Tristychius*," published in this journal three years ago *.

The spine is described as being $1\frac{2}{3}$ inch in length; it is tolerably slender, and, according to the figure, is pretty sharply curved backwards beyond the middle. "Its surface is smooth; but a shallow and wide groove occupies a nearly central position along the middle third of the spine." Posteriorly it shows along its distal fourth seven strong, pointed, recurved denticles, in connexion with which the writer remarks that "the second row (if existent) is concealed in the matrix." The walls are described as being "apparently thick and the pulp-cavity small," and it is further stated that the inserted portion of the spine is not preserved.

* Ann. & Mag. Nat. Hist. (5) xii. pp. 177–190, pl. vii.

That this spine was new there can be no doubt; its reference to Agassiz's genus *Tristychius* is another matter.

Tristychius arcuatus, the type of the genus, was described and figured by Agassiz in the 'Poissons Fossiles,' vol. iii. p. 21, Atlas, vol. iii. pl. i. *a*. figs. 9, 10, 11; and the very beautiful original specimen, from the Carboniferous-Limestone series of the neighbourhood of Glasgow, is now in the museum of Anderson's College in that city. I have carefully examined that specimen, as well as a large number of others from various Scotch Lower-Carboniferous beds, and may therefore sum up the essential characters of this spine as follows:—

Specimens occur from 1 inch to nearly 5 inches in length: in shape the spine is gently and gracefully curved backwards, tapering to a point; and it must be noted that some examples are more strongly curved towards the apex than others. The extremity is longitudinally sharply sulcated or ridged, the ridges mostly soon disappearing until, at a distance of from 1 to $1\frac{1}{2}$ inch from the point, usually three only remain—one median and two lateral, which pass down beyond the others along the anterior aspect of the spine towards the base. The inserted portion is not, as in *Ctenacanthus*, *Hybodus*, or *Gyracanthus*, distinctly marked off from the exserted, and the former, as well as the non-ridged part of the exposed surface, is closely covered with minute and delicate longitudinal furrows mingled with pores. The base is hollow, with rather thin walls, which are always crushed in by pressure; posteriorly this hollow is widely open by the usual sulcus, superiorly it passes up into the narrow pulp-cavity of the closed portion of the spine. Above the closure of the sulcus the posterior aspect shows a rather narrow concave area, bounded by two prominent edges, immediately within which latter there is on each side a row of strong recurved hooks or denticles; towards the apex the denticles of each row are very close together and alternate in their arrangement; and, as I have already emphasized in my notes on *Gyracanthus* *, the young spines are not miniatures of the larger ones, but represent only their distal portions, so that the *proportion* of the surface covered by longitudinal ridges varies according to the size of the specimen. In very small ones the entire exserted surface may appear fluted, while in one very large specimen, in which the apical portion is *worn* away, only the three long ridges remain.

Although Agassiz did not enter quite so much into detail in his description, yet the leading characters of the genus were

* Ann. & Mag. Nat. Hist. (5) xiii. p. 41.

very well grasped by him in his definition of *Tristychius*, and he lays particular stress upon the presence of the three long ridges, on which he in fact founded his generic name. But if we compare Agassiz's figure of *T. arcuatus* with that of Mr. Stock's "*Tristychius*" *fimbriatus*, it will be apparent that the two forms have hardly that amount of resemblance which would warrant reference to a common genus. Agassiz's *Tristychius* is eminently ridged and striated—Mr. Stock's spine is perfectly smooth. The former is gently curved and tapering, and shaped generally like the spine of *Hybodus*; the latter is nearly as thick at the extremity as at the middle, and shows, moreover, a very peculiar sudden backward curve. To this curve Mr. Stock attaches "very slight importance,"

Fig. 1.

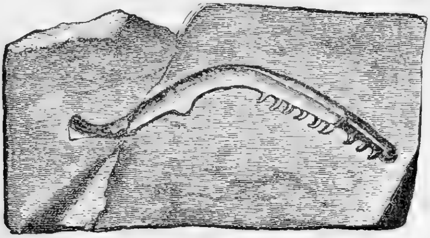

Fig. 2.

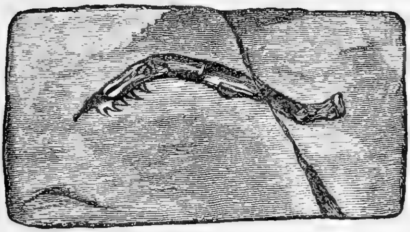

Fig. 1.—*Harpacanthus fimbriatus*, Stock, sp. Here the greater part of the spine is seen only in impression.

Fig. 2.—The other side or counterpart of the same specimen, containing more of the actual spine, but wanting the impression of the distal extremity, which has splintered off.

remarking also that it is "possibly due to disease;" and he has also given a "restoration" of the spine, in which he has to a large extent straightened it out, so as to make it look rather more like that of the genus in which he has placed it.

A second specimen of the same spine has, however, subsequently been found in the same locality by Mr. W. Anderson, now of the Geological Survey of New South Wales, to whom, along with Mr. W. Tait Kinnear, the discovery of the first

was also due. This specimen having been presented by Mr. Anderson to the Edinburgh Museum of Science and Art, I am now in a position to say a few words as to its characters.

On comparing this spine with Mr. Stock's figure (*op. cit.* pl. vii. fig. 1) there can be no hesitation as to identifying it with his *Tristychius fimbriatus.* It is 2 inches in length by about $\frac{1}{8}$ inch in antero-posterior diameter at the thickest part (about the middle), and presents a strong backward curvature, though not quite so strong as in Mr. Stock's specimen; and it may also be noted that the bend takes place nearer the middle of the spine. Above the base the posterior margin of the spine is rounded, the anterior rather sharp; the sides are flattened, and beyond the curve show a longitudinal shallow groove, the surface all over being perfectly smooth and destitute alike of the coarser ridges and more delicate striæ of *Tristychius.* A considerable amount of the substance of the basal extremity of the spine is lost by being broken away; but what remains, along with the excellent impression, shows that there was no posterior sulcus—that the basal extremity was, in fact, solid; a pulp-cavity is very soon seen extending towards the apex. Furthermore there is no posterior area; but about $\frac{6}{10}$ inch from the inferior extremity there is a small rounded backward projection, beyond which again, and commencing $\frac{7}{10}$ inch from the bluntly rounded apex, the rest of the posterior margin is occupied by a series of nine strong recurved denticles, which are in this specimen clearly seen to form *one* median row.

It is therefore not only clear that the spine described by Mr. Stock as *Tristychius fimbriatus* cannot possibly be referred to *Tristychius*, but that it also displays peculiarities which remove it still more widely from that genus, and such allied forms as *Ctenacanthus*, *Hybodus*, &c., than might have been supposed; for not only is the posterior area wanting and the row of denticles a single one, but the base is altogether different in not presenting the spacious hollow or sulcus open posteriorly. The occurrence of the second specimen shows also that the posterior curvature is natural and not the result of accident or disease.

It is, however, clearly a Selachian appendage; more I do not at present say regarding it. So far, however, as I am aware, it does not seem to have been hitherto generically recognized, and I therefore propose for it the term *Harpacanthus* *, so that the name will now stand *Harpacanthus fimbriatus*, Stock, sp.

* *ἅρπη*, a sickle, and *ἄκανθα*, a spine.

XLVI.—*Description of a new Species of Saw-fly from Albania.* By W. F. Kirby.

Macrophya cora.

Macrophya Saundersi, Kirby, Journ. Linn. Soc., Zool. xx. p. 37, pl. i. fig. 11 (1886).

Allied to *M. Hartigi*, Kirb.

Exp. al. 20 millim., long. corp. 10 millim.

Female.—Black; all the mouth-parts below the antennæ, except the mandibles, which are black, ivory-white; ocelli red; occipital ridge with two small yellow spots in the middle; collar, tegulæ, scutellum, cenchri, and a large spot on the mesopleura yellow; abdomen black, first segment with a narrow, whitish, terminal, transverse stripe in the middle above, and segments 3 to 7 inclusive with narrow, terminal, whitish, lateral stripes on the ventral surface; coxæ black, striped with pale yellow on the outside for their whole length; trochanters yellow; femora black, tipped with yellow (very slightly on the hind femora); tibiæ yellow, narrowly tipped with black, and the front tibiæ lined with black on the inner side, the apical spines yellowish; front tarsi black, yellow on the outside; intermediate tarsi black above and yellow beneath, hind tarsi entirely black.

One female in the British Museum from Albania, obtained from the late Sir S. S. Saunders's collection.

By some oversight this species was figured in the 'Journal of the Linnean Society' as *M. Saundersi*, in place of another new species from the same collection, described under that name in Journ. Linn. Soc., Zool. xx. p. 34.

MISCELLANEOUS.

The Homologies of the Larvæ of Comatulæ. By M. J. Barrois.

Hitherto the larvæ of Comatulæ have been compared only with the Holothurian larvæ with several circles of cilia, the part of the larva which will form the calyx being regarded as anterior, and that which will form the peduncle as posterior. This theory, which makes a Crinoid to be something comparable with a Holothurian fixed by its posterior extremity narrowed into a peduncle, is confirmed, as results from my investigations, by the evolution of the

tentacular sac. (In both this sac originates from an invagination of the ectoderm situated at the level of the third circle of cilia, which afterwards loses its relation with the ventral surface, to open at the apex of the anterior extremity.) But this theory is completely contradicted by another character of higher value, which consists in the situation of the two primitive apertures of the embryo, which I have indicated in a preceding notice. Starting from this fundamental character we arrive at a new conception which it now remains for me to explain.

Development shows us that the closure of the blastopore is effected not far from the spot where the aperture of the calyx will afterwards appear, and that the ventral pit (*fossette ventrale*) of authors corresponds in situation with the buccal invagination of the other Echinoderm-larvæ. From this it results that, instead of regarding the region of the calyx as anterior and the region of the peduncle as posterior, we must, on the contrary, regard as anterior the portion of the larva which becomes the peduncle, and as posterior that portion which becomes the calyx, so that the Pentacrinoid cannot be considered to originate from a larva attached by its posterior part, but, on the contrary, from one fixed by its anterior part, by its preoral lobe.

If we now pass to the homologies, we find that this type of development can only be compared with the larvæ of which the entire posterior part becomes transformed into an Echinoderm, while their anterior part is of provisional existence.

Of this number are the Echinids and Starfishes. Investigations still unpublished upon the metamorphosis of the Sea-Urchins have led me to conclude that the larva (leaving out of consideration the purely accessory organs, the arms, and ciliary fringe) must be regarded as composed of two parts—the anterior formed by the portion projecting above the subumbrella, which includes the preoral lobe *plus* the œsophageal region; the posterior composed of all the rest of the body. In the metamorphosis the former of these two parts becomes detached at its base, while the whole of the second becomes transformed into a Sea-Urchin.

In these two constituent parts of the pluteus of the Echinids we may see portions corresponding to the two fundamental divisions (calyx and peduncle) of the larvæ of Comatulæ; their destiny is the same, only the anterior caducous region of the Echinid pluteus never attaches itself and falls earlier.

As to the concordance above indicated between the evolution of the tentacular sac of the Comatulæ and Holothurians, it seems equally to exist between the Comatulæ and the Sea-Urchins, in which we find the homologue of this sac in the part described by Metschnikoff under the name of *amnios*.—*Comptes Rendus,* Nov. 8, 1886, p. 892.

Notes on the Distribution of Ceratella fusca, *Gray.* By J. Brazier, C.M.Z.S.

A specimen of this Hydroid Zoophyte has been in the Australian Museum for a number of years placed with the Gorgonoid Corals. Only a few weeks ago, when clearing out some of the cellar-rooms in the Museum, Mr. Whitelegge found in some glass jars in spirits some very fine specimens, supposed to have been obtained in the trawl by *employés* of the Fisheries Commission of New South Wales. It does not appear, however, that any records of the trawling, dates, or depths have been recorded, and the only locality given, "off Sydney Heads," is a wide term indeed.

Genus Ceratella, Gray, 1868.

Ceratella fusca, Gray.

Ceratella fusca, Gray, Proc. Zool. Soc. Nov. 26, 1868, p. 579, fig. 2; Carter, Ann. & Mag. Nat. Hist. 4 ser. vol. xi. no. 61, Jan. 1873, pp. 8–10; Bale, Catalogue of Australian Hydroid Zoophytes, 1884, p. 48; Von Lendenfeld, Proc. Linn. Soc. N. S. W. 1884, vol. ix. p. 612.

Hab. Head of Bondi Bay, N. S. W. (*J. E. Gray*); Wreck Bay, south of Jervis Bay, N. S. W., found on the beach after S.E. gale (*J. Brazier*, 1870); Broughton Islands, north of Port Jackson, 33–35 fathoms (*Australian Museum*, Nov. 1880); Port Jackson Heads (*Australian Museum*, Sept. 1879); off Port Jackson Heads (*N. S. W. Fisheries Commission*), no record of depth, specimens in Australian Museum; Bondi Bay, found in grass-wrack after S.E. gale (*T. Whitelegge*, May 30, 1886).

The whole of the specimens are in a splendid state of preservation. A portion of the specimen obtained by Mr. Whitelegge in May has been mounted by him for microscopical examination.

Dr. von Lendenfeld, in his paper on the Australian Hydromedusæ (*loc. cit.* p. 612), is very curt when he says that Dr. Gray's description "is worthless." If the description is worthless the figure given by Gray is to the point in all that is required, for though this naturalist generally gave a short description of nearly everything he described, he always took care to give good figures.

Mr. H. J. Carter, F.R.S., in his valuable paper on the Hydractiniidæ (*loc. cit.* p. 10), calls attention to the excellent illustrations given by Dr. Gray, and any scientist who has seen them cannot but acquiesce. When Dr. E. P. Ramsay was in London some two years ago, he obtained from the British Museum some Hydroids, named by the authorities of that institution, and among them is a specimen of *Dehitella atrorubens*, Gray, Algoa Bay, with a reference name *Ceratella fusca*, Gray. This is undoubtedly *Dehitella atrorubens*, Gray, the Australian Museum never having received any specimen or specimens of *Ceratella fusca*, Gray, from the British Museum.—*Proc. Linn. Soc. of New South Wales*, vol. i. 2nd ser., June 30, 1886, pp. 575, 576.

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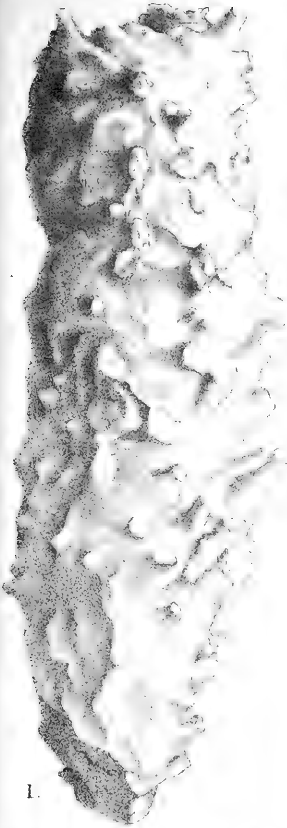

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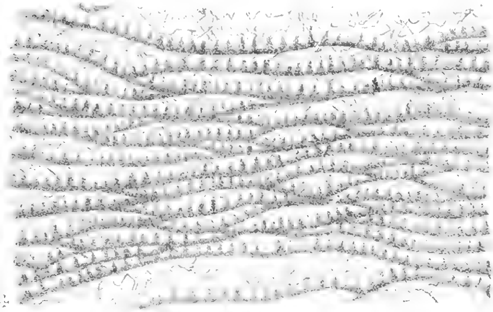

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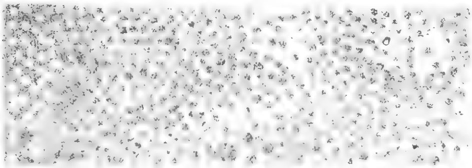

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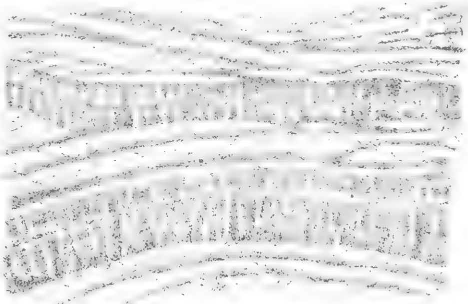

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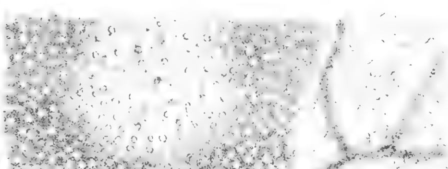

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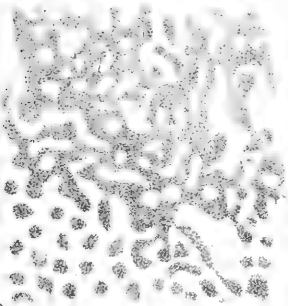

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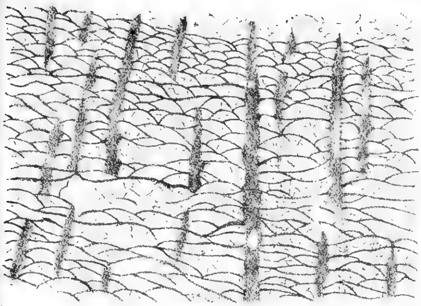

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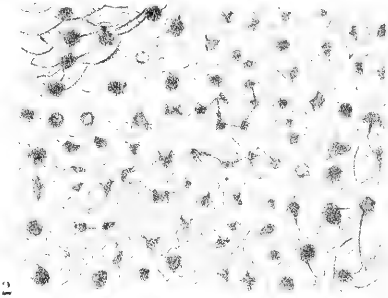

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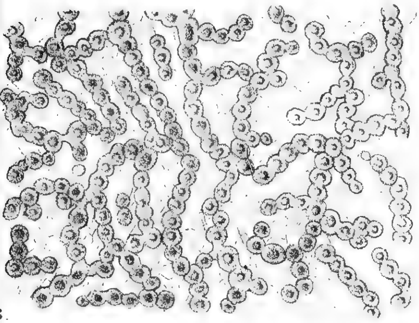

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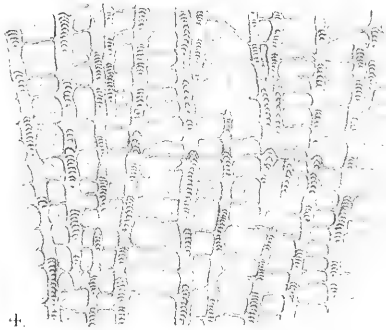

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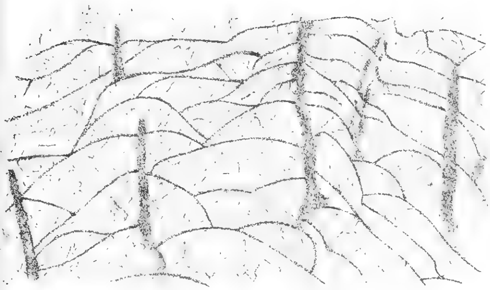

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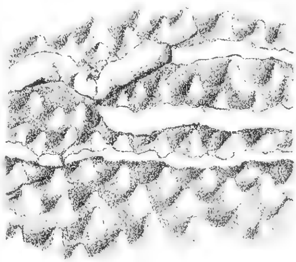

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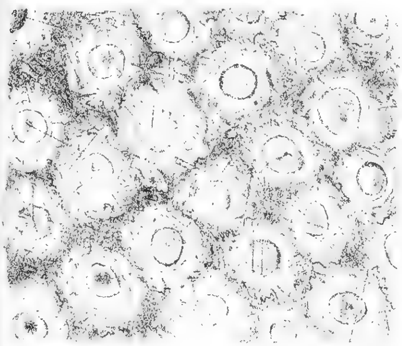

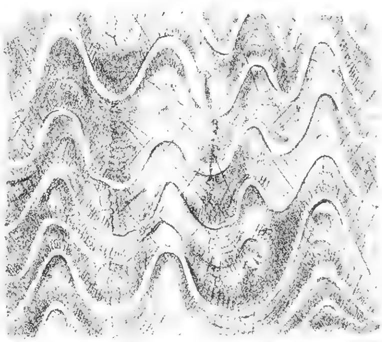

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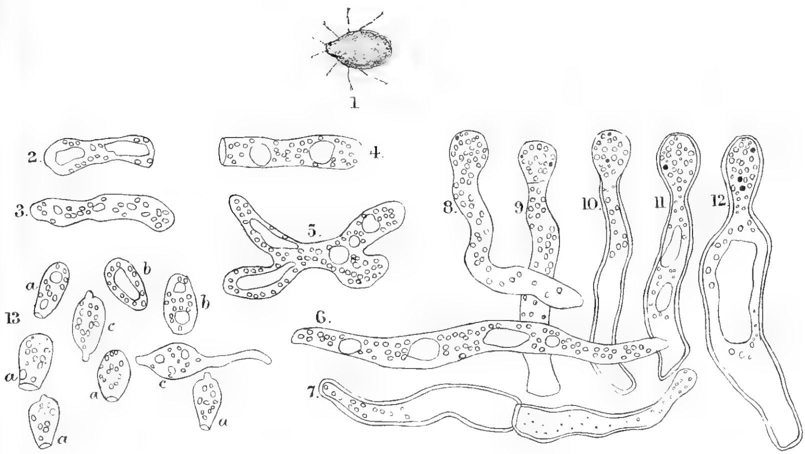

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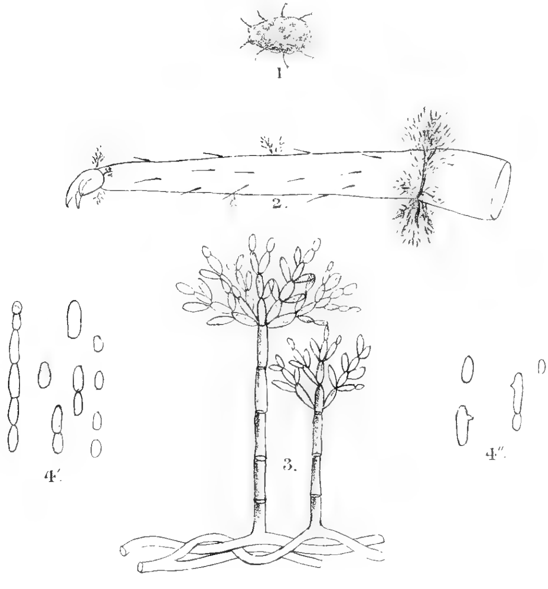

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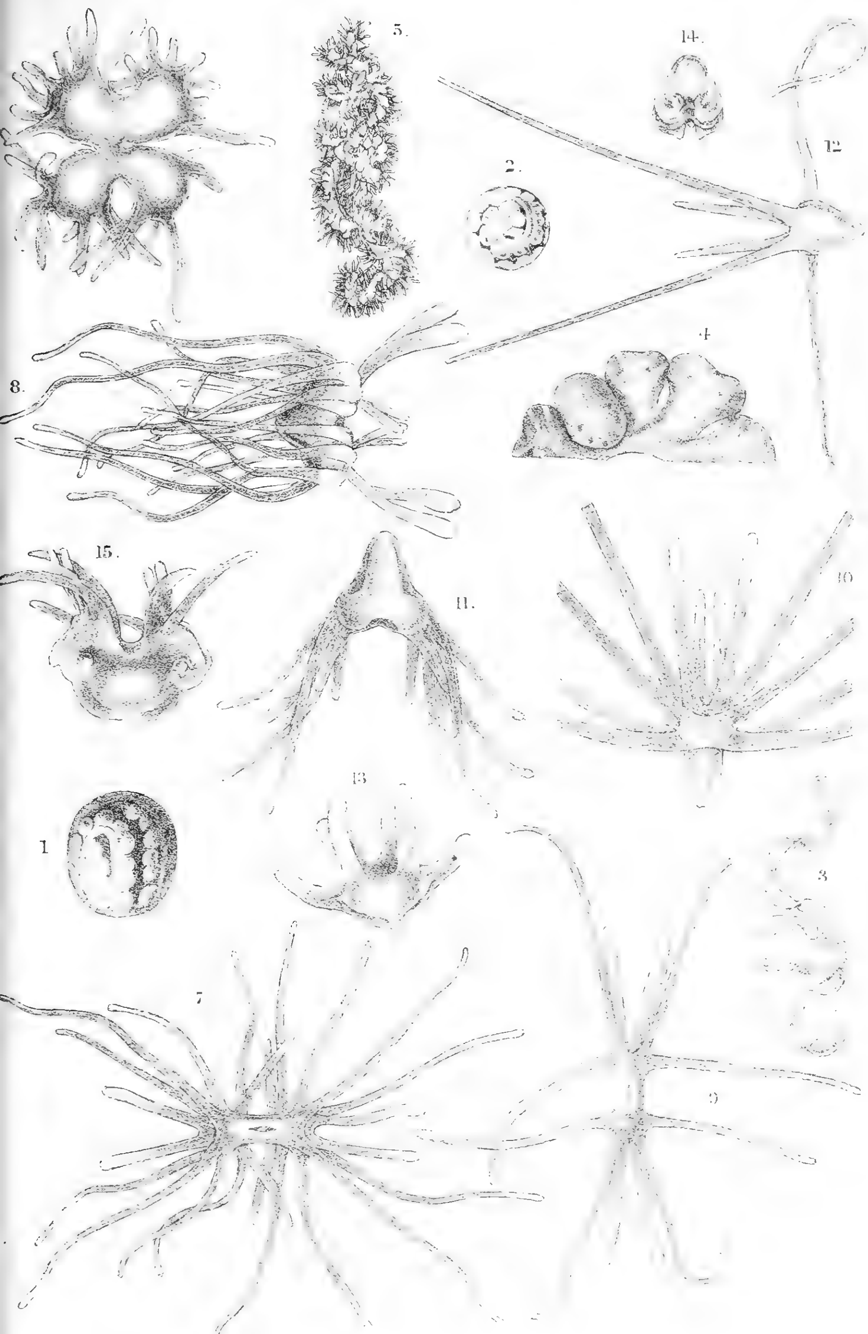
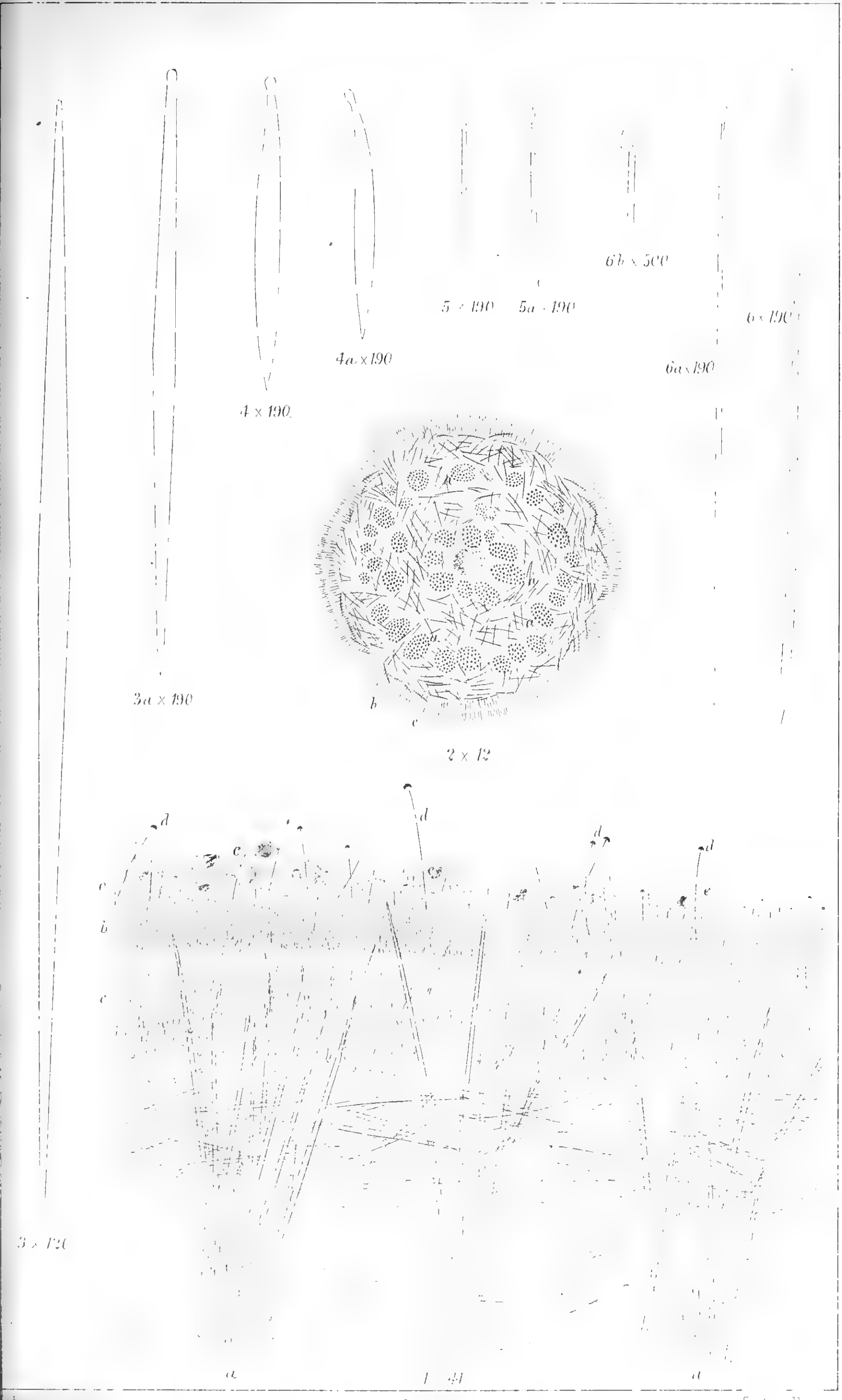
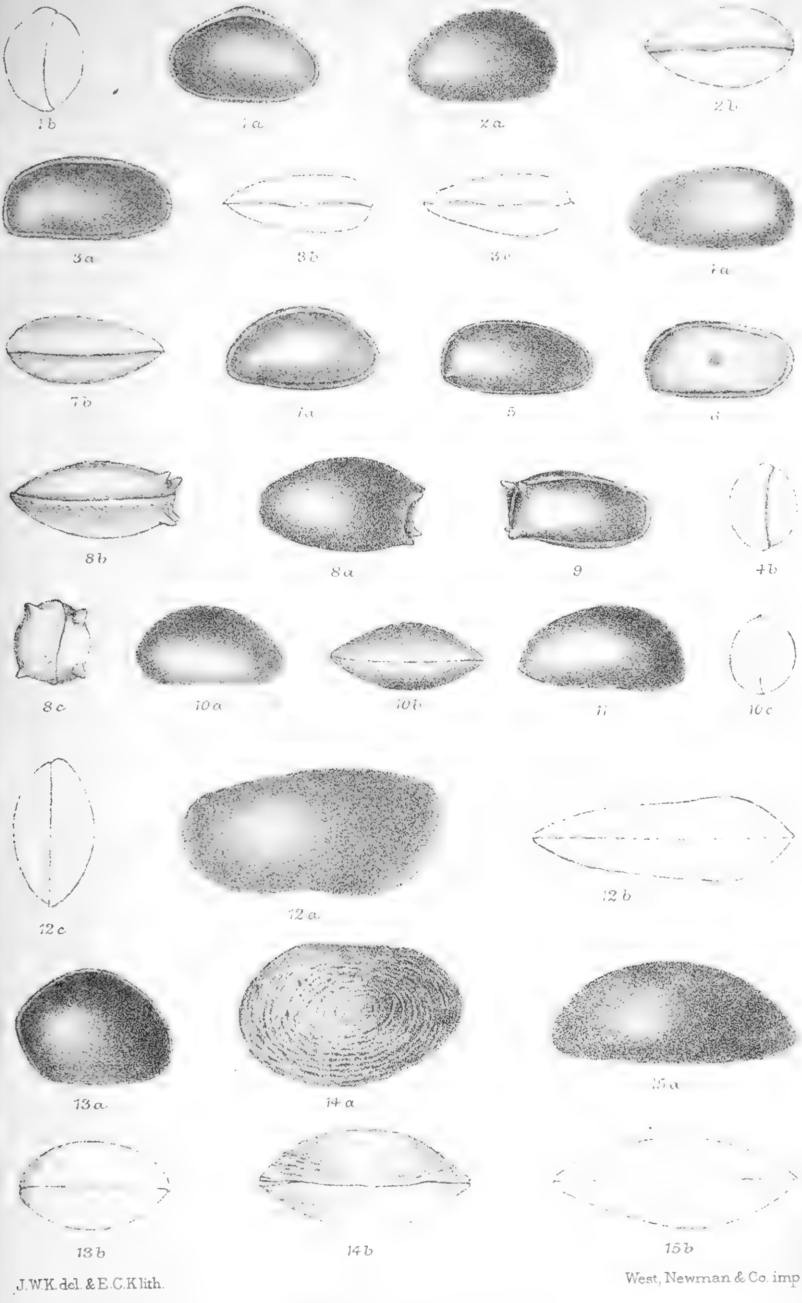


Mintern Bros. lith.

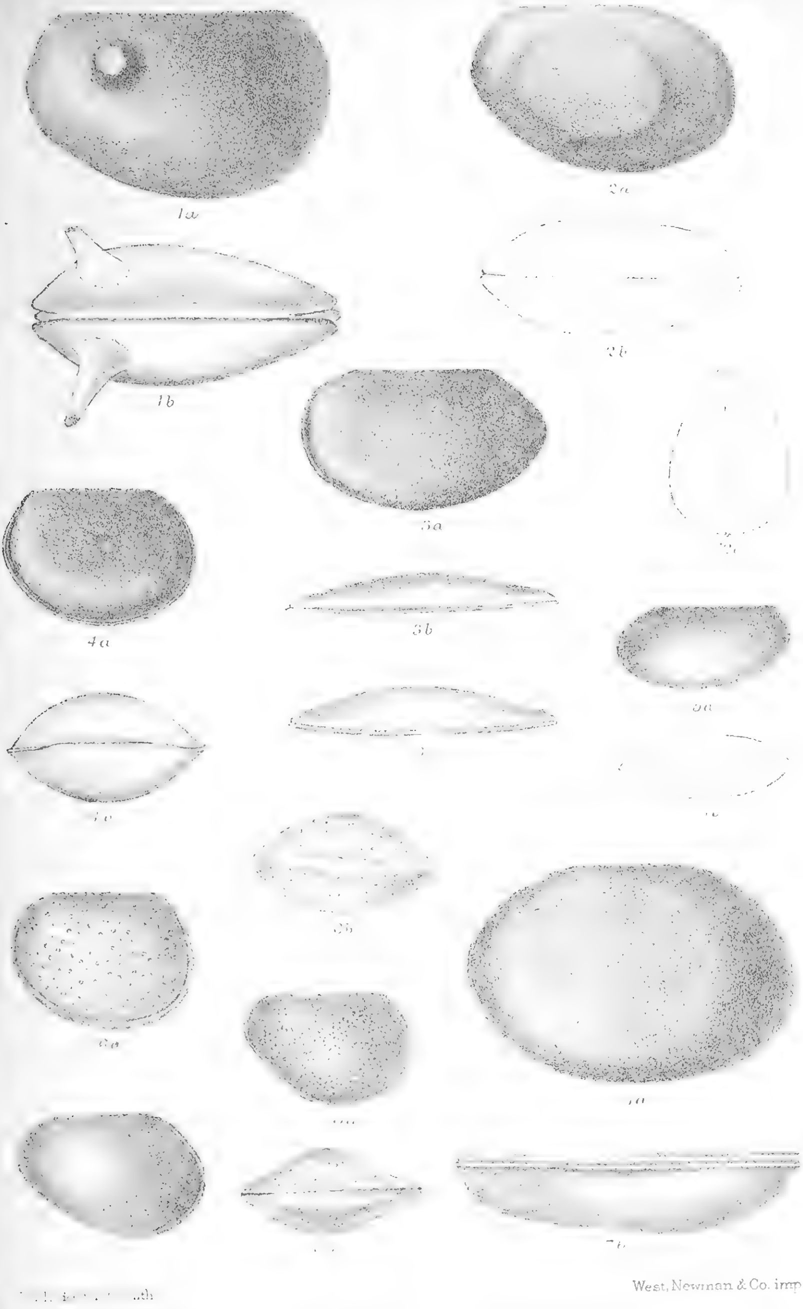

3a × 190
4 × 190.
4a × 190
5 × 190
5a × 190
6b × 500
6a × 190
6 × 190
2 × 12



J. W. K. del. & E. C. K lith.

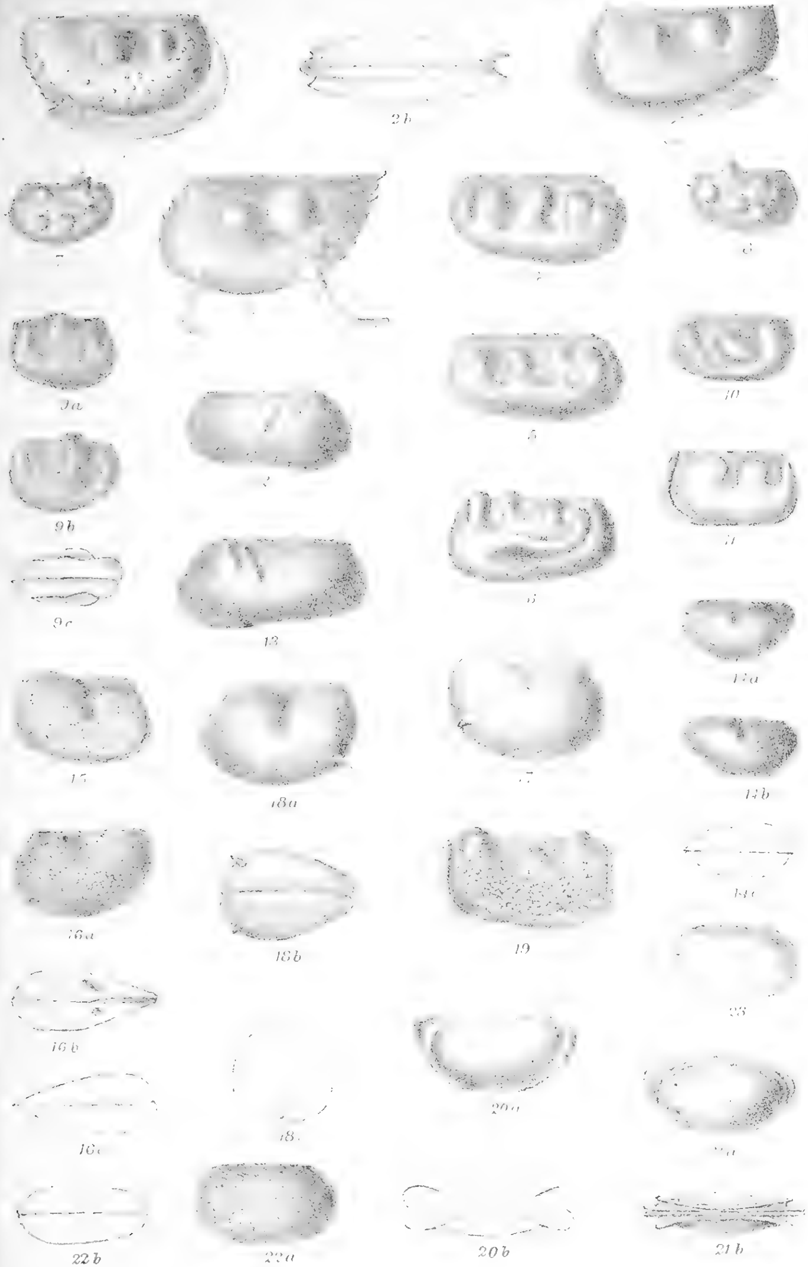
West, Newman & Co. imp.

Carboniferous Ostracoda.



West, Newman & Co. imp.

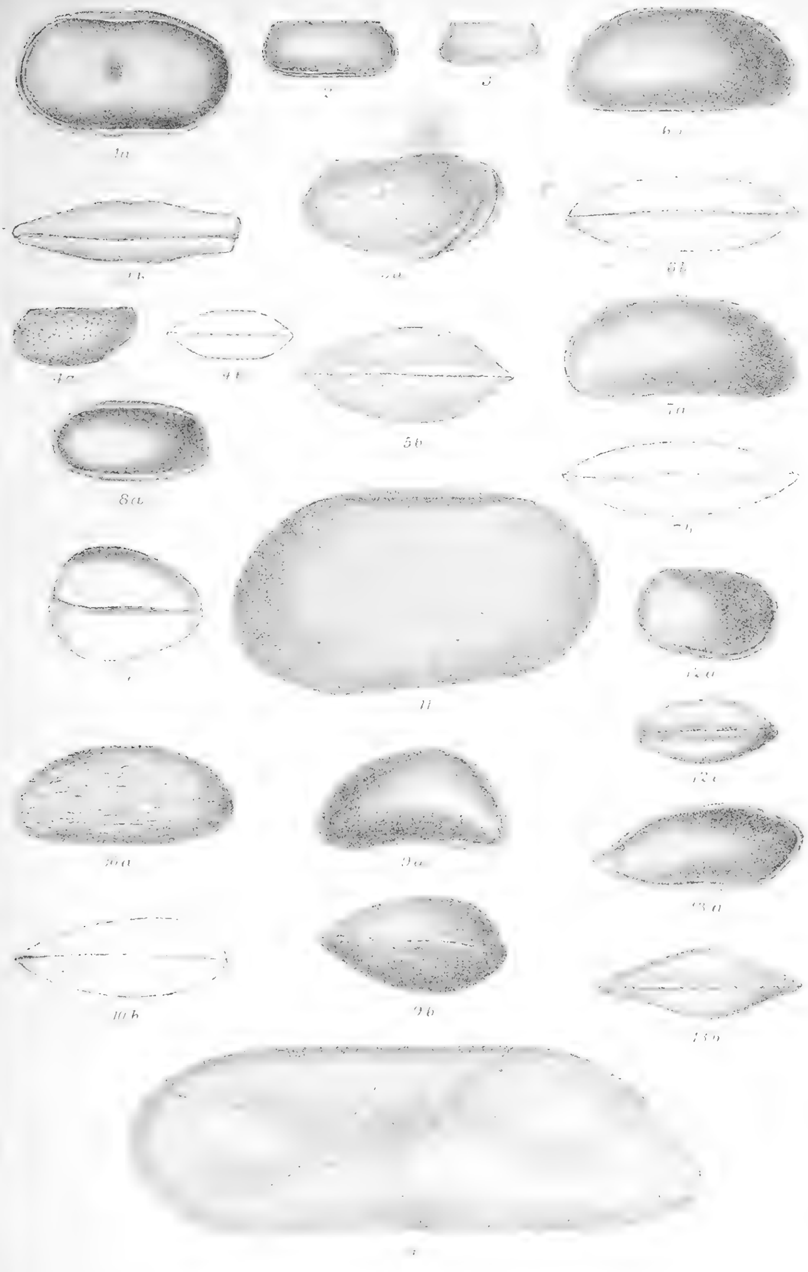
Carboniferous Ostracoda.



J.W.K. del. & E.C.K. lith.

West, Newman & Co imp.

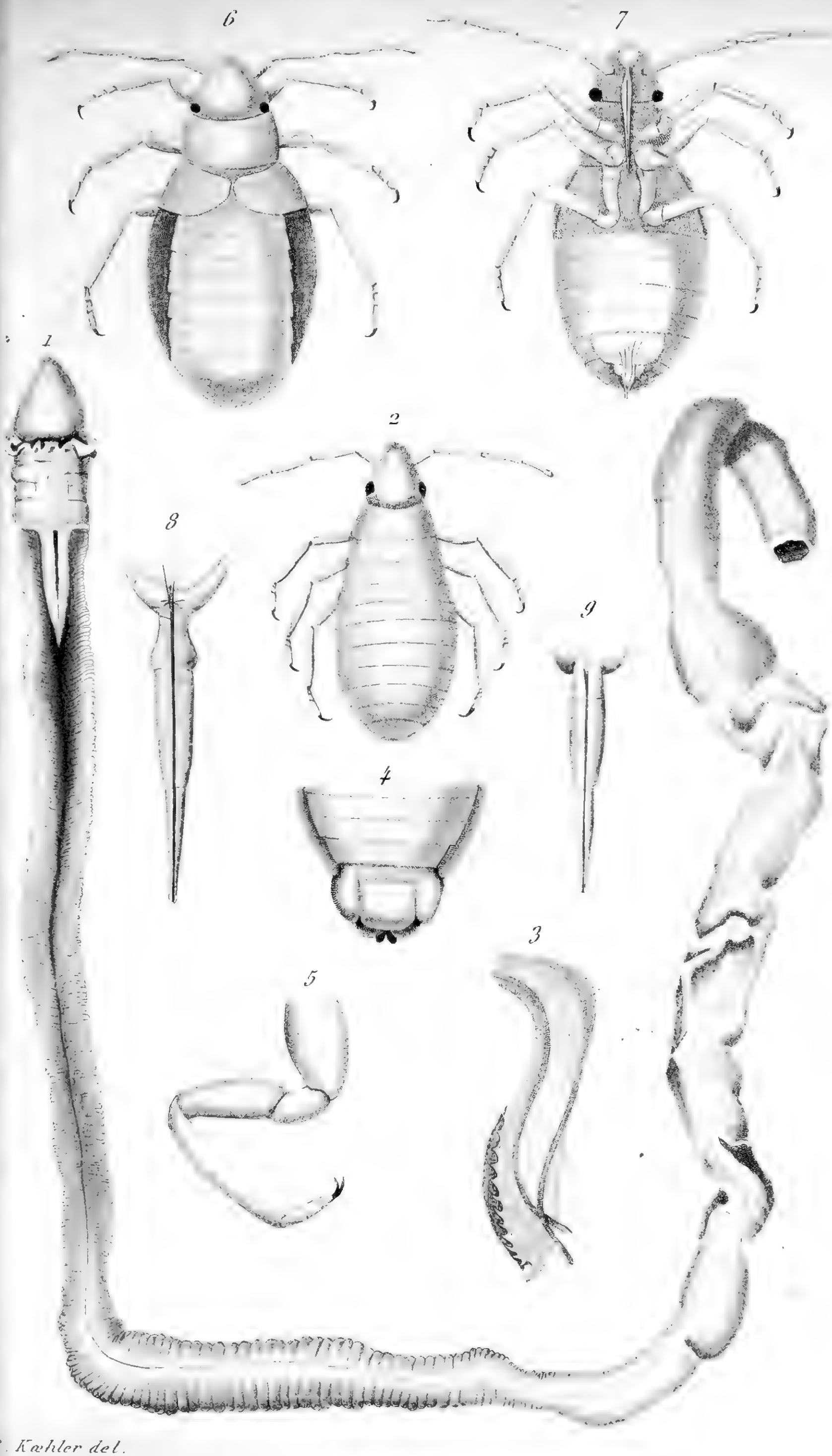
Carboniferous Ostracoda.



J. W. K. del. & E. C. K. lith.

West, Newman & Co. imp.

Carboniferous Ostracoda.



R. Kœhler del.